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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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The Brotherhood's Railway Plan

OVERSHADOWING all other great public questions of the day except the high cost of living—of which it is a part—is, "What shall be done with the railways?" Plan after plan has been proposed, commented on by a larger of smaller number of proponents and opponents and all but forgotten except by a comparatively few. Among these plans will probably be classed before long the one formulated by a committee of the Chamber of Commerce of the United States and approved as to 9 of its 10 points by a "referendum vote" of business organizations, as announced in detail on p. 292. But the plan that surpasses all others in the general interest it has created and the discussion it seems likely to cause among the people at large is the one announced by the four large railway brotherhoods in the Sunday papers, Aug. 3. Formulated in more or less detail some time ago and indorsed since by the American Federation of Labor, the Plumb plan is now before Congress. An outline of its provisions appears on p. 290. The chief of these are Federal ownership of the railways, and their lease for operation to a corporation with directors representing equally the public, the railway officers and the railway employees. Profits from operation would be divided equally between (1) the public and (2) the officers and the wage earners. The plan has taken on greatly added significance because of the circumstances of its announcement, which tied it and the railway wage problem so skillfully into the high cost of living. Put forward in this way and as a virtual demand of two million railway employees for Government ownership of railways, the Plumb plan should be given close study to determine the effect of its adoption upon the railways, their employees and, last but not least, upon the public at large.

Helping City Planning Along

WIDESPREAD progress in city planning is the order of the day. Scores of cities have commissions devoted exclusively to this subject. Many of these commissions, probably most of them, have little more than advisory powers and very few have funds sufficient to enable them to gather the data and secure the expert assistance necessary to enable them to give good advice to the city authorities or to the general electorate who control he city purse and policies. At the best much general educational work is required to convince city councils and taxpayers that city planning pays. In a few of our progressive cities there have been promising attempts to secure coöperation by various civic and commercial organizations. A recent example is afforded at Dallas, Tex., where the Chamber of Commerce and the City-Planning Commission, working through the Metropolitan Development Association, are attempting to unite "all the Dallas business and civic organizations to meet properly the demands" of the rapid growth of that city "by undertaking a comprehensive, far-sighted program of practical city planning accomplishments," for which purpose an effort is being made to raise $35,000 yearly to maintain "a permanent office" and employ "experienced city-planning experts." This is commendable but ultimately the city itself should establish and finance city-planning studies, coördinating them and the execution of the plans with other city activities. Otherwise the best of plans are likely to remain where so many such now are—on paper, accumulating dust in pigeon holes. Few of our cities have yet learned that city planning is a function that they should assume without further procrastination. Coöperative action like this at Dallas will hasten the day.

Coöperation of Engineers and Contractors

COÖPERATION of engineers and contractors on highway work—and, in fact, upon all work—is essential to the best results. A tendency on either side to bulldoze the other is always a detriment to the job. In a visit to a highway office recently, the remark was made to the editor, "If a contractor comes into the office and says something good about an inspector, we 'fire' the inspector." While this was probably said in jest, still it represents a feeling which took that form of expression. If the engineer is overbearing, it creates in the contractor a desire to get even, which will generally be accomplished in spite of the engineer. A characteristic of all contract work should be a spirit of coöperation between the contractor who performs the work and the engineer who supervises it. Only by such harmony, fostered by a spirit of give-and-take, can the best results be obtained.

Care in Foundation Work Spells Safety

A COFFERDAM accident noted on p. 268 illustrates the fact that care and caution in foundation work are necessary for the proper prosecution of the work as well as for the stability of the future structure, which latter point was discussed in *Engineering News-Record* of May 29, 1919, p. 1043. In this present case a tunnel was known to exist beneath the site, but instead of careful preliminary investigation and bulkheading it seems to have been assumed that the tunnel was not an element of danger, and a chance was taken in letting it fill with water. The result was that the water, under high head, forced its way out through the surrounding ground and flooded a cofferdam in which foundation work was in progress. No lives were lost and no great damage was done, but the delay of ten weeks was a serious interruption to progress.

Public Improvement Programs Hampered By Local Authorities

THROUGH a weak point in the municipal government system of many cities, it happens too frequently that well considered plans for public improvements, prepared by competent men, may be seriously changed to meet the whims of inexpert local officials. This has been illustrated forcibly in the recent council discussions of the Chicago lake-front improvement ordinance, involving an expenditure of approximately $140,000,000.

After several years of debate, an ordinance was drafted that had the approval of all the conflicting interests, including a council committee, and was further indorsed by a special railway terminal commission. No sooner was this ordinance introduced in the city council than it became the target for attacks which took the form mainly of innumerable amendments imposing additional requirements upon the railway whose terminals are to be rebuilt. There was little regard for the relation of these amendments to the project as a whole, and they were carried so far that acceptance of the ordinance by the railway company was endangered.

The trouble comes in part from the ward system of representation. To the average alderman the interest of his ward comes first and that of the city comes second, while one of his main aims is to "get something" for his ward in order to prove to his constituents that he is actively representing them. Should the interests of the city require something adverse to his ward, he would try to defeat the proposed measure.

In part, also, there was the assumption that a railway company was a fair object of attack and might be loaded with any and every additional work and expense. In fact, there seemed to be an idea that the railway was asking a favor and therefore should shoulder any such additional work. Its representatives finally had to insist there were limits to the conditions under which it could accept the ordinance.

This experience brings to mind the tendency of the people to set themselves up as experts or judges in technical matters ("mobexpertocracy") discussed in our issues of June 14, 1917, p. 563, and June 5, 1919, p. 1091, and the habit on the part of public officials of making decisions on technical matters without asking or heeding technical advice, as commented on July 10, 1919, p. 49. True, it cannot be denied that a city ordinance is put through its various council stages to give opportunity for decision and amendment; and that representative government implies consideration of the interests of all classes of those represented; and that in many if not all cases the chosen representatives means well. But all this does not alter the fact that the interests of the city as a whole should come before those of a ward or class. Some think the remedy lies in election at large instead of ward representation. Others pin their faith on proportional representation. Each plan has its merits, but they are not sufficient in either case, for something more fundamental than the basis of representation or any other element in the framework of government is needed. The public must be educated to elect and to trust representatives of higher caliber and broader judgment, who will not only legislate more wisely and impartially but will also select specially trained men for executive positions, and put more confidence in their judgment in engineering and allied matters.

Cost Engineering as a Science

COSTS are of the essence of engineering. An appreciation of their importance, and the ability to control them, distinguish the successful engineer from his less fortunate brother—assuming always a proper grounding in the technique of design and construction. And yet, in spite of the wide acceptance of this statement as a fact, the science of cost keeping has not kept progress with the technique of the profession. The contractor of necessity ought to know his costs, and the engineer-designer and construction supervisor has to follow those costs in order to perform properly his part of the work, but, except among the large contractors whose business is on an extremely sound basis, costs are too loosely kept and too frequently misinterpreted.

War, with its vast accompaniment of construction, laid the basis for a more intensive study of the science of cost keeping. In the first place, practically all the contracts were let on a cost-plus basis, which of necessity led to the most detailed of cost records. But, besides this, the work had all to be done at record speed, which meant that the layout of prospective work must be most definite and the adherence of performance to expectation be close. No better measure of progress could be found than the record of cost—or at least, progress could be best recorded as a part of the cost-keeping procedure.

Thus it came about that all of the construction branches of the Government began the development of cost-recording methods on a scale never before attempted. It is a fair indication of the state of the science that practically every one embarked on his own scheme from the beginning, independent of the past or of the others engaged in the same study, and each, now that his system is developed, is willing to defend it as the best and most workable ever proposed.

One of the most elaborate of these systems is that used by the United States Housing Corporation, to which a number of pages of this issue are devoted. Although the work of this bureau was of a special type—that is, an aggregation of small operations, duplicated many times at many different places—the cost and progress records exhibit in admirable form the fundamental requirements of any such system. Large expenditures of money and effort are subdivided into minute details, which in themselves can be observed and recorded without much complication or difficulty. These details, however, are so recorded as to permit of ready accumulation into composite units which present to the executive a picture of the whole, but which at the same time may be traced back to their source if occasion demands. A record of progress at any instant is available by observation; costs, for whatever purpose, are readily obtainable.

The Housing Corporation's scheme, too, exhibits the apparent defects common to all cost and progress records on so large a scale. The details of observation and record seem innumerable and the multitude of results confusing. Actually, however, in such systems most of the operations soon become routine and are as easily performed as the results to which they lead are understood and applied.

Dr. Mann in his famous report emphasized the importance of cost study in the new engineering education. Here, then, is a part of a new course in, say, engineering accounting, made to hand. In their

elements such systems are bookkeeping of a higher sort, and may be left, as too often they have been in the past, to bookkeepers, but really they require much more than mere accounting skill. They run back to the bases of engineering knowledge and should, therefore, be a part of every engineer's equipment. In fact, Messrs. Prior and Green point out that in their work they found that engineers made the best material for their cost men, not only because of the technical fundamentals of the work but because of their adaptability and their direct pursuit of the fact to its source. Engineering cannot ever be merely building cheaply and quickly, but the best engineering in the world falls short of what it should be unless it is completed at the lowest possible cost and at the greatest possible speed. Any method of study which will encourage young engineers to develop this cost and speed sense will add much to the practice of engineering.

Traffic Control on Feeder Highways

MORE than a year ago, when the agitation for the regulation of motor-truck weights, sizes and speeds was just starting, we called attention to the various phases of the problem (*Engineering News-Record*, May 16, 1918, p. 939). One matter discussed was the liberty to be allowed the heavy truck on the inadequately improved cross-roads. The question was stated as follows: "What shall be done with the side roads? Shall all roads be built the same, so that the concentrated load of the occasional heavy truck which happens to go on the side road shall not destroy it, or shall a system of licensing, with prescribed zones, in which certain weights of trucks may operate, be employed?" The first alternative is not debatable, as it is manifestly impossible, financially, to comply with the conditions. The second, however, warrants attention.

At the present time a maximum load of 28,000 lb., including the weight of the truck and its burden, has been tentatively agreed upon by truck manufacturers, truck owners and highway engineers, and this standard will be pressed in all the state legislatures. It becomes a matter of grave concern as to whether this truck shall be allowed on feeder roads. It is of concern to the public to protect its investment in the type of road which composes the greater portion of its highways; it is of concern to the engineer who must provide, as best he can, for the ever-increasing maintenance charges due to traffic conditions, and it is of concern to the truck operator, who wants to know whether he can buy a uniform weight of truck of the maximum size, or whether he is to be held up with certain portions of his business at the side roads, being compelled to transfer to a lighter truck to complete the transportation. In his case it might be advisable to use the light truck for the entire movement.

Since it is evident that our highways cannot all be made to bear 28,000-lb. loads the year round, it seems necessary that some means for protecting lighter construction be considered at once, and before great damage is done to our more common roads at the expense of general ill-feeling against the destructive agent.

In considering what loads and speeds may be allowed, various factors enter the problem. In the types of construction most generally found on the cross-road, beam action is practically absent from the road crust, and the load-bearing power of the subsoil is the detail that must be considered. This bearing power is not only dependent upon the quality of the soil, but also upon its condition as regards moisture content. Many earth roads will safely carry a heavy motor truck in seasons when they are perfectly dry, and if it is possible to operate over them at all in wet weather, the damage is easily repaired. Not so with the light macadam construction which is practically broken up by the heavy motor truck when a soft subgrade exists, and can only be repaired at heavy cost.

Again, the crushing strength of the aggregate in the macadam road, affecting the internal wear under heavy motor-truck concentrations, would possibly exclude the 28,000-lb. truck, even in the dry season. Another factor which enters the problem is the light construction of the bridges on many of the side roads, which were built before motor-truck transportation was contemplated. What shall be the maximum loads allowed in the wet season? And what in the dry season? Shall maximum loads be different for different seasons of the year and different types of road and bridge construction?

Aside from maximum load, the speed of vehicles must also be considered, and this, instead of showing a maximum destructive effect in the wet season, will be more damaging in the dry season. The load impact and the consequent internal wear in the macadam road will be greatly affected by the speed of the vehicle. Again, the effect of rubber tires, particularly pneumatic, upon macadam roads is well known, and it often occurs that a light automobile will do more damage to a dry macadam road than a heavy, slow-moving truck. The speed maximum for macadam should therefore be established with reference to the dry- and not the wet-season wear.

When once a set of regulations has been promulgated, taking into consideration the type of road, the condition of the bridges, the weight and speed for different seasons of the year, etc., how shall these regulations be enforced? It is common knowledge that many regulations of motor trucks are continually disregarded by operators. The first consideration in the enforcement of such a set of regulations would seem to be the posting at each road intersection of either printed signs or easily distinguished symbols, to inform the driver what regulations apply to the road which he is about to traverse. There are many cases, no doubt, where adjacent cross-roads would call for entirely different traffic regulations.

Any system of signs that might be used would have to be such as to be quickly distinguished, so that a large loss of time might not occur in determining the conditions. On the main roads, licensing would solve the problem of weights and dimensions. On the feeder roads, should separate licenses be required, with special license tags which might easily be checked up by citizens living on the road, or should police supervision, which would be expensive in the country districts, be depended upon to enforce the rules?

Enough has been said to show the intricate character of the problem. It is in order for those interested to institute studies for its solution, and as it would seem logical and preferable to press before the legislatures a single statute covering both the main and feeder roads, it is hoped that those who have suggested the solution for the main road will now bend their energies to the solution of the feeder-road problem.

Keeping the Costs of Building the Government Houses

System of Reporting Progress and Cost Used by the United States Housing Corporation—Methods Devised and Operated by Engineers Applicable to One Building or to Complete Towns

By John C. Prior and Herbert P Green

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EXPERIENCE has demonstrated that the keeping of progress and cost records is an indispensable adjunct to the successful supervision of construction on a vast scale, and that in actual dollars and cents such reports pay for the cost of their preparation many times. In the construction of the many housing projects for the Government during the war, the United States Housing Corporation, which had an appropriation of $100,000,000 for war housing, developed a system of producing and keeping such records which served admirably to present a running picture of the status of the work on each project but which also preserved for future use the exact costs to the finest detail. Such a system is equally well adapted to a small undertaking as to the large ones for which it was devised.

Fundamental Principles

In designing reports for a busy executive, one paramount consideration is to have important features stand out so prominently that they may be seen at a glance. Details may be taken up afterward in the order of their importance.

Applying this principle to progress and cost reports on housing developments means that the reports should show standing out foremost a single figure to indicate *progress* to date, and another single figure to indicate the efficiency of the project as expressed by its *cost*. These single figures may include the construction of hundreds of houses of various types and sizes, stores, schools and other public buildings, a complete system of streets, sewers, water mains and other utilities, as well as the beautification of the grounds.

These single figures should be instantly comparable with the time schedule and the cost estimates, as well as with past performances, so that improvement or retrogression may be apparent.

Should the officials find these figures normal, the report is passed with no loss of time. On the other hand, if the figures are found to be unsatisfactory, the cause is immediately sought. Therefore, the report next analyzes the figures into their components, which are similar figures for buildings and for utilities.

The field is thus somewhat narrowed, but further subdivision is necessary. Hence, the next step is to divide buildings into groups, each group containing all buildings of the same general character, and to divide the utilities into the principal branches, such as streets, sewers, water lines, etc. After the difficulty has been traced to certain groups, the next step separates these groups into the various trades or operations, and in some cases these must be again subdivided into the minor operations. By following unsatisfactory components through to the smallest subdivision, the trouble is thus traced quickly to the very trade or operation which is delaying the work or running up the cost.

But to get the single index figures, which are the peak of a pyramid, we have to reverse the process and build up from the foundation. We have to begin with the details and proceed logically to the peak—the final answer sought. In the description of a report, hereinafter, we use this method.

The adoption of a unit cost system with units selected for detail and for breadth, amply met all requirements. In order that costs may always be comparable with estimates, it is necessary to use unit costs as well as total costs.

Standardization, with sufficient flexibility to take care of features peculiar to the individual developments, is a prime requisite for any system of progress and cost reporting which is used on many scattered projects.

As far as practical the system should automatically emphasize items which have the greatest effect on ultimate cost and on time of completion. The operation of the Housing Corporation is such that the cost of *materials* is almost a fixed unit. But the cost of *labor* used for incorporating materials into the finished structure is almost entirely dependent upon the efficiency of field supervision. Speed of erection also depends upon field supervision. Hence, much more time and care should be devoted to compiling labor reports than material reports. Also, some individual items in house construction consume a larger proportion of the whole cost and time than do other items. Thus, "Rough Carpentry" and "Masonry" are larger items and should have more thorough attention than "Sheet-Metal Work" or "Installation of Lighting Fixtures."

Construction Organization of Corporation

The policy of the Corporation was to organize itself on a combination of the line and staff systems. This is the best method to give responsibility to a man and to hold him responsible for the results.

It would have been a difficult matter to build up rapidly a hundred or more construction organizations, each complete and smoothly running. Hence, it was deemed advisable to absorb into the Corporation as many organizations as possible, and to make the Corporation organization a controlling one. Contractors had organizations, and each had his own method of enlarging them more quickly than the Corporation could create new organizations of the same size.

But while it was the policy of the Corporation to hold the contractor responsible for his organization and its accomplishments he could not be left to himself. Especially during war construction he could not get results as quickly nor as economically as he could if the Government were back of him. Hence, the Corporation did get back of him. It placed with him, to coöperate with him, certain representatives who were specialists in accomplishing the desired results. These men were a works superintendent, inspectors, engineers, an auditor and a cost engineer. While acting with the contractor, these men remained definitely a part of the Government organization, assigned not only to assist the contractor, but also to see that he performed his contract.

In order to follow the working of this principle, it is necessary to consider the form of contract evolved. This form is known as a "cost-plus-a-fixed-fee" contract.

This means that the Corporation pays for the actual cost of labor and material entering into the construction, and for the overhead cost of the project. The con-

tractor is paid a definite sum, agreed upon beforehand, for the use of his nucleus of an organization, his plant, equipment, supervision and personal attention, and for his constructive efforts in building up a large organization to accomplish the purpose of the contract.

But if the contractor has a contract in which the owner pays all bills and he gets a definite profit regardless of what the work costs or how long he takes to do it, the human tendency might be not to accomplish as much as possible. It was therefore deemed advisable to have bonus and penalty clauses in the contracts which would give two additional incentives to perform the work expeditiously and economically.

Most of the contracts allowed a bonus of twenty-five per cent of the saving, in case the contractor by reason of skill in executive management and organizing ability reduced the total cost of the work below his estimate, and exacted a penalty of twenty-five per cent of the loss, if the total cost exceeded his estimate, both the bonus and the penalty being limited to fifty per cent of the fee.

The bonus was further modified by a clause which required that to collect it the contractor must complete his work within the time he estimated.

The contracts of course allowed an equitable revision of both the money and time estimates to cover changes made by the Corporation, and for certain other contingencies beyond the control of the contractor.

As these clauses are personal matters to the contractor they are found to loom very large in his eyes. Hence he watches very closely the two items that the Corporation wishes him to watch—progress and cost.

The contractors are determined by a competitive bid, but this competition is not limited to dollars and cents. Some contractors might underfigure others, but not be able to carry the contract to completion. Hence, the form of bid contains in addition to the estimate of the probable cost of the work a statement of the contractor's past accomplishments, what composes the nucleus of his organization, what equipment and plant he has available, what capital he can command if necessary, what time he will take to do the work, and the fixed fee he will accept for his services.

All of these items are considered in making the award. The contract contains a restatement of the essence of each of these items. Not the least item is the estimate of the probable cost of the work. When the contractor reecives a contract and the estimate is reduced to the documentary form required by the Corporation, this estimate is known as the "Official Estimate."

The responsibility of living up to this official estimate is entirely upon the contractor. He has studied the plans of the work, has analyzed the component elements, has studied the labor and material situation, and has reached certain conclusions. He has combined his past experience with these new-given conditions into a comprehensive statement of *quantities* of work, *units* of cost, and *total* cost.

After being awarded a contract, the contractor is required to rewrite his estimate on forms prepared by the Cost Engineering Section. Complete instructions in regard to compiling these sheets are printed thereon, so that a competent estimator for the contractor can easily transform the contractor's own form of estimate into the standard form. The items into which the estimates are subdivided are units of standard construction with which all builders are familiar. Examples of these subdivisions are given in the detailed problem worked out hereafter.

Making the Official Estimate

The Official Estimate consists of three printed forms. Each form adopts given standard units of measurement.

The estimates are made by inserting the estimated number of these units required and the estimated cost of each unit, and by obtaining the products of these assumptions.

The first form includes all buildings. It is designed to show the quantities required for each type of building, and for each trade or operation. It shows the unit costs for labor and for material. It shows the total costs for labor and for material, and the totals to complete each trade or operation. The total cost is shown for one building of each type, as well as for all the buildings of each type.

The number of sheets required for buildings depends upon the number of types involved. This form is very flexible and makes possible the combination of such house groups as is deemed advisable.

The second form is used for the utilities estimate. On this form the estimate is first broken down into the principal groups, streets, sewers, water mains, etc., and these are again subdivided into their principal items. For example, sewers are classified by sizes. The size for each sewer is given, as is also the number of lineal feet required, the average cut, the unit cost for excavation and backfill, the unit cost for laying, the unit cost for hauling, the total unit cost for labor, the unit cost for material, the total cost for labor and for material, and the total cost for that particular size of sewer. Similar treatment is accorded all other items making up the various groups, standard units being used wherever possible.

The third form summarizes the preceding two. In addition it shows in detail the estimated cost of overhead, the cost for plant rental, and the fee for the contractor's services. The total of this third form equals the total amount stated in the contract, and these documents are made a part of the contract. The forms themselves are too voluminous for reproduction in this article.

The contractor proceeds with his contract on the agreement that he will work to accomplish the estimated results. This Official Estimate is the standard which enables the Corporation to compare what he does with what he said he would do.

In reporting progress and cost the corporation is able to judge performance better from records which are made by itself than from records which the contractor might make. Contractors' methods vary greatly—hence they must be standardized. It is the duty of the Cost Engineering Section to standardize these methods and to keep the records constantly up to date.

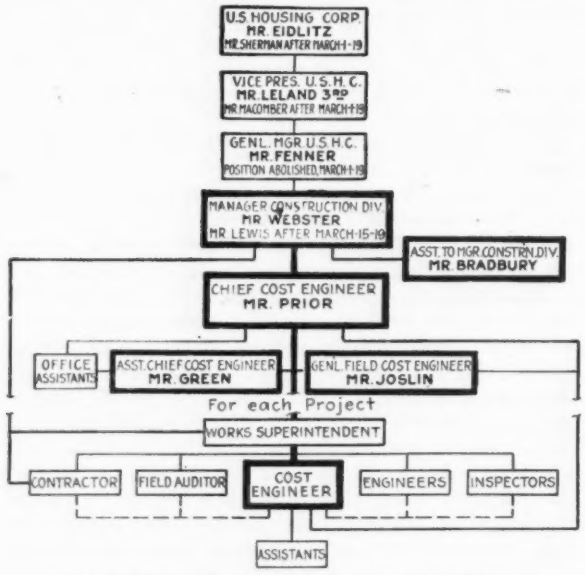
It would be difficult to keep reports momentarily up to date, hence definite periods have to be adopted for the ends of reports. An interval of two weeks between reports was adopted after considering, on the one hand, the desirability of having the reports as nearly up to date as possible, and, on the other hand, the amount of time necessary for their preparation and the fluctuations in unit costs for very short periods.

Cost engineering, as developed by the Housing Cor-

poration, performs two functions: First, compiling complete, immediate and accurate comparative records of *progress* and *cost* of work performed, and second, utilizing this information to improve the existing conditions.

The organization which the Housing Corporation established for these purposes is shown in Fig. 1.

The first function, that of compiling comparative records, is primarily the duty of the Cost Engineering Section. However, this section has the periodic assistance of other divisions in gathering the necessary information, for it is the policy of the Corporation to



FUNCTIONS OF PRINCIPAL ELEMENTS

ASST. TO MGR. CON. DIV.	ASST. CHIEF COST ENGR.	CHIEF COST ENGINEER	GENL. FIELD COST ENGR.	COST ENGINEER
Analyze reports for information and work with contractor and works superintendent to devise means whereby cost may be reduced and progress accelerated.	Systematize and standardize operation and information. Work to general efficiency of the organization, supplement work of chief cost engineer.	Formulate policies, organize departments. Correlate activities.	Co-ordinate field activities, obtain official estimates, educate field assistants, act as field representative of chief cost engineer	Prepare cost reports, progress reports, special reports

FIG. 1. ORGANIZATION CHART OF COST ENGINEERING SECTION OF UNITED STATES HOUSING CORPORATION

keep the field force reduced to a minimum to avoid overlapping of duties.

The Fiscal Division, represented on the chart by the Field Auditor, acting in connection with the contractor's field force, performs all routine bookkeeping and auditing matters, and distributes the costs to certain accounts, as required by the Cost Engineering Section.

The quantity of production is obtained by actual measurements made on the job as the work progresses. The cost engineer is responsible for obtaining the measurements of production, but is aided by the inspectors and the utility engineer.

The Cost Engineering Section takes the information thus gathered and puts it into a permanent and understandable form.

The second function, namely, that of improving conditions, is vested in the general manager of the Construction Division. He appoints as his assistant a man who is eespecially diplomatic and forceful, and conversant with contractors' methods. His particular duty is to take from the Cost and Progress Reports the vital information therein, and to work with the contractor and with the works superintendent, to the end that cost may be reduced and progress accelerated.

The system adopted may be divided broadly into field and office methods. Because of many considerations, it was determined to make the field do all the work possible, leaving only the planning, systematizing, directing, coördinating and gleaning to be done at headquarters. The principal advantage of doing it this way, rather than by concentrating the work at Washington, was that it made the system so flexible that it could be applied to one building only or to a thousand towns with very little difference in the headquarters force. To do this, resident cost engineers had to be intensively trained in the Washington office, in order that they might be sent to the field thoroughly conversant with the duties required.

The men themselves are the most important part of the system. If we could not have secured good men, we could not have worked the system. As the system had to be flexible though standardized it was necessary to employ men who were themselves flexible though standardized. Of all classes of men, those with an engineering training seem to possess this quality of adjusting themselves to conditions as they find them, better than any other class. This is because they are taught to take what they find and create out of it what they want. Their training enables them to see broadly the purpose back of their routine work and thus to grasp the important and to disregard the irrelevant. In short, they should be what the word "engineer" really means—trained and *ingenious* men.

But even the most ingenious man cannot do full justice to his work, unless he knows precisely what is wanted, and in what form it should be presented. Hence, it was necessary for the central office to prepare a Manual of Instructions in advance of construction, setting forth in a clear and concise way the duties of a resident cost engineer and his relation to the other members of the field force. The Manual included in addition a complete set of cost engineering forms for a hypothetical example.

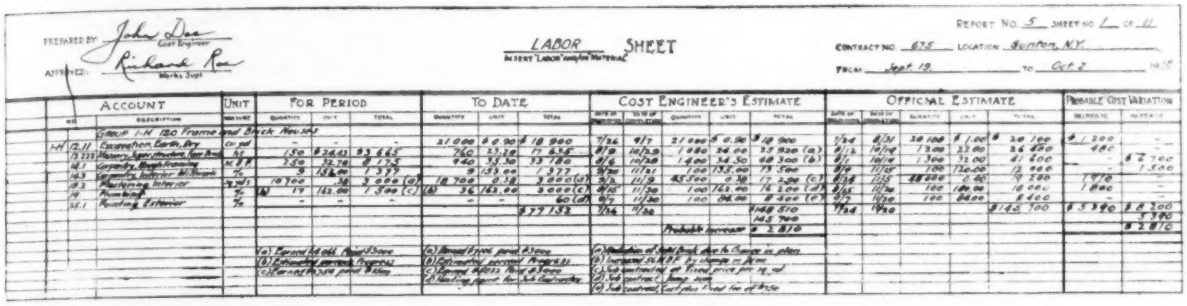
Among the ordinary printed forms in use by the Corporation may be mentioned several which are important for the cost engineer, but as they are not unique they will be only mentioned. These are the Foremen's Daily Work Reports, the time-keeping and checking forms, the weekly payrolls, the material requisitions, the invoice tracers, and the expense register. These are all brought together into a comprehensive scheme in the Construction Record, and it is from the Construction Record that the bulk of the cost engineer's figures as to expenditures are taken. This information is complemented by information he gains at first hand from various sources, and is checked by his personal examination into a certain proportion of the detail, so that he can satisfy himself of its correctness in principles and its approximate correctness in facts.

The tables given herewith, illustrating standard documents developed by us, are not intended to be a duplication of the *shape* of the forms used, but are intended to indicate the principles of computation adopted. Nor do the values used indicate any particular relation to any actual project.

Table I indicates the tabular form into which the cost engineer first gathers the information coming to him

TABLE I. COMPARISON BETWEEN A CONTRACTOR'S ESTIMATE AND HIS PERFORMANCE

The information given is taken from records made by the contractor, audited by the field auditor, and supplemented and elucidated by the cost engineer. Progress and cost are shown *For Period* of time covered by the report, and for all time. *To Date* from beginning of the work. *The Cost Engineer's Estimate* of what he believes will be the total is given, as well as the Contractor's *Official Estimate* of what he thought would be the total.



A report generally includes many such tables, one for labor and one for material for each Main Group, one for Overhead, and one for the Project as a Whole. Material sheets are not included until the fourth report, and thereafter are included in even-numbered reports only.

For the purpose of illustration, a hypothetical project is assumed. It will include two groups of houses served by streets, sewers and water mains. Calculations and illustrations of forms will be given for one group of houses only. In this group, all but a few of the necessary trades or operations will be eliminated. To make the illustration include most of the conditions met in actual progress and cost reporting, it is further assumed that the project will require some twenty weeks for its completion, and that the construction has been under way for about ten weeks. This brings the project to the point where the fifth Biweekly Report is made.

The Main Group given in the hypothetical example herewith is known as 1 H and contains the labor for seven subdivisions or trades. All others have been eliminated for brevity, but the ones included are sufficient to illustrate the general principle involved. A complete Main Group for Houses generally includes about twenty to twenty-five subdivisions, and a Main Group for Utilities about five or six. The Main Groups adopted are as follows:

Houses, Group 1	1 H	Sewage-disposal plant	S D
Houses, Group 2	2 H	Sewage-pumping plant	S P
Houses, Group 25, etc	25 H	Sewers	S R
Bridges and culverts	B C	Street railways	R
Docks	D	Streets	S T
Electric lines and plants	E	Telephone lines	T
Garbage-disposal plant	G D	Water mains	W
Gas mains	G	Water-pumping plant	W P
General	G E	Water-purification plant	W F
Heating plant	H P	Water towers	W T

The preparation of reports is greatly simplified by reducing the number of house groups to a minimum. Hence, the buildings are divided into groups only when their character is distinctly different or where the development includes several sites.

There are thirty-three sets of subdivisions, generally by trades, and to each is assigned a whole number, beginning with ten. Each set is divided by decimals into parts which are different in nearly every trade. The subdivisions may be a part of any Main Group to which it is desired to assign them. One set of subdivisions is here given:

12. EXCAVATION
- .1 Earth
  - .11 Dry
  - .12 Wet
- .2 Rock
  - .21 Solid
  - .22 Loose
- .3 Cofferdam
- .4 Sheet piling
- .5 Bracing and shoring
- .6 Borrowed earth
- .7 Back fill

Referring again to Table I, the first column (No.) shows a Main Group and its subdivisions in standard symbols.

The second column ("Description") gives popular descriptions of the operations, so that persons not familiar with the classification numbers may know the operations without referring to the Manual.

The third column gives the units of measure for the different classes of work. Such items as are difficult to reduce to cubic, square or linear units are appraised on a percentage basis, but reporting in percentage is discouraged because it is not as accurate as measuring in definite units. Plumbing, heating, lighting, millwork, painting, landscaping and cleaning up may be reported in per cent.

It will be noticed that the portion of the table to the right of the third column is divided into five main columns: 1. "For Period," 2 "To Date," 3. "Cost Engineer's Estimate," 4. "Official Estimate," and 5. "Probable Cost Variation."

Each of the first four of these columns contains the quantity of work, the unit of cost, and the total cost for each subdivision

The "For Period" is for the period of time shown at the top of the sheet.

The "To Date" column includes all the work completed since the project began.

The "Cost Engineer's Estimate" contains figures which he and the works superintendent anticipate will be nearly correct at the completion of the project. The column is revised from time to time by the cost engineer, with the approval of the works superintendent, as new information is obtained indicating new conditions not foreseen at the time of the last revision of the "Cost Engineer's Estimate."

As the Official Estimate is the *base* of all computations, it is intended that it shall not be changed. A comparison between the other three columns and this column gives the measure of efficiency of the project as compared with the standard at first adopted. If the standard at first adopted is not met, it is reflected immediately by the difference between the other columns and this one. The dollar variation between the Cost Engineer's Estimate and the Official Estimate is shown in the last column, "Probable Cost Variation."

Both the "Cost Engineer's Estimate" column and the "Official Estimate" column contain dates for the beginning and for the completion of subdivisions of the work, and for the whole group.

In studying Table I, the following is some of the in-

formation which may be gathered from the first line taken in connection with the headings and notes. Item 12.11, "Labor on Excavation, Earth, Dry," has been completed with 900 more cu.yd. than estimated, but at 10c. per cubic yard less than estimated, making a total of $1200 decrease in cost. The fact that it is completed is shown by the quantity and unit totals in the "To Date" column being the same as the corresponding items in the "Cost Engineer's Estimate" column. It is also learned that the work was originally intended to be started on July 24 and completed on August 31, but that it was not started until two days later and was not completed until seven days later than planned, i.e., on

TABLE II. PROGRESS AND COST EACH EXPRESSED IN A SINGLE FIGURE FOR AN ENTIRE PROJECT—OR FOR AN ENTIRE GROUP OF HOUSES WITH INDIVIDUAL HOUSES IN MANY STAGES OF COMPLETION

By inserting in this form certain figures from Table I the cost engineer is enabled to compute the progress which has been made and the efficiency of the labor.

	% PROGRESS TO DATE Based on Cost Engineer's Estimate					% UNIT COST TO DATE Based on Official Estimate				
CLASS NO.	QUANTITY TO DATE	QUANTITY COST ENGRS. EST.	% COMPLETE	WEIGHT	WEIGHT × %	UNIT COST TO DATE	UNIT COST OFF. EST.	% UNIT COST	WEIGHT	WEIGHT × %
1-H										
12.11	21 000	21 000	100	12.7	1270	0.90	1.00	90	13.8	1242
13.222	760	1 080	70	17.5	1225	23.20	22.00	105	18.1	1900
14.1	940	1 400	67	32.5	2178	35.30	32.00	110	28.6	3146
14.3	9	100	9	9.1	82	153.00	120.00	127	8.2	1041
18.2	18 700	45 500	41	11.7	479	0.38	.40	95	13.2	1254
19.	36	100	36	10.9	392	162.00	150.00	90	12.3	1107
25.1	0	100	0	5.6	0	-	-	-	5.8	-
				100.0	5626				100.0	9690
	5626/100 = 56.3% PROGRESS					9690/94.2 = 102.9% UNIT COST				
PROJECT AS A WHOLE										
1-H			56.3	40.	2252			102.9	39.	4013
2-H			38.	30.	1140			93	31.	2883
ST			8.	15.	120			96	14.	1344
W			100	6.	600			95	6.	570
SR			42.	9.	378			128	10.	1280
				100.	4490				100.	10050
	4490/100 = 44.9% PROGRESS					10050/100 = 100.5% UNIT COST				

July 26 and September 7, respectively. As these dates are prior to the period of the report, no work is included in "For Period" column.

In the same way, other lines may be analyzed. In "Face Brick Work" there is a reduced quantity expected, a part of the reduction being caused by a change in plan. The reduction in quantity will cause a net decrease in dollars in spite of an expected increase in unit cost. The unit cost to date is not as great as the Cost Engineer's Unit Estimate, which shows that he expects the last part of the work to cost more than the work up to this time. If the period is indicative of the future, the unit cost for the period bears out his assumption. This work began three days ahead of schedule but probably will be ten days late in finishing.

"Rough Carpentry," according to the Cost Engineer's Estimate, was originally underestimated as to quantity, but more than half of the increase has been caused by a change in plan. The same estimate shows that labor for erection will cost more per thousand board feet than at first expected. The work done to date has cost even a higher rate, but the unit cost for period is showing improvement. Increased unit cost, faulty quantity estimating, and changes in plan, have all contributed to a considerable probable increase in total cost. This item was late in starting and probably will be relatively still later in finishing.

For "Carpentry, Interior Millwork," the "To Date" and "For Period" columns are alike, indicating that this item was started during the current period. The unit cost is considerably above the official estimate. As most of the work is yet to be done, the cost engineer estimates that the unit cost will be reduced and the excess cost absorbed somewhat, but that the unit cost cannot reach the originally estimated rate for all of the work. An overrun in total cost probably will result.

Interior plastering has been subcontracted at a fixed price per square yard two cents less than the Official Estimate. The quantity to be placed will probably be less than the estimate. Note that the quantities "For Period" and "To Date" multiplied by the unit costs do not equal the dollars in the total columns. This is due to the fact that actual payments to the subcontractor lag behind his production. In fact, the payments are based on previous reports.

The cost engineer should explain items involving special conditions by placing notes at the bottom of the sheet as shown, and he may discuss them more fully in the letter of transmittal.

Analysis on a Percentage Basis

For the purpose of further analysis of Progress and Cost to Date, another statement is compiled giving the results on a percentage basis. This form is recast for our example herein as Table II

The same classification numbers given in Table I are inserted in the first column. The left half of the rest of the sheet refers to Progress and the right half to Cost.

It will be noticed that "Progress to Date" is based on the Cost Engineer's Estimate, for this estimate is a statement of the best knowledge of what 100% of the work will be. Progress of each item is given in per cent of the Cost Engineer's Estimate. Items not started are of course reported as zero per cent complete.

When it is noted that the first item is 100% complete the second 70%, the third 67%, the fourth 9%, etc., the first question that arises is, "What progress has been made on the whole group?"

A correct answer to this query cannot be obtained by merely averaging the percentages, because some items require much more labor than others. Hence a column marked "Weight" is added. In this column figures are given which represent the relative importance of each item to the whole group of which each is a part. The group is taken as 100. The product of the per cent complete for each item and its weight is then carried to the next column. The sum of this column divided by 100 gives the per cent progress of the group. In the example this figure is 56.3 per cent.

In a similar manner the groups which compose a project are combined to obtain the progress for the project as a whole. For progress the weights should express the relative production each item will contribute to the whole group compared with all other items in the group.

On the assumption that labor is paid in proportion to what it produces, weights are based on labor costs. This method of fixing weights is simple to apply and leads

TABLE III. PROBABLE TOTAL COST OF PROJECT WITH AN ANALYSIS OF VARIATIONS FROM OFFICIAL ESTIMATE

COMPARISON BETWEEN COST ENGINEER'S AND OFFICIAL ESTIMATE

CONTRACT #675 Gunton, N.Y. FROM Sept 19 TO Oct 2, 1918

		PROBABLE COST VARIATION DECREASE	PROBABLE COST VARIATION INCREASE
DIRECT LABOR			
OVERRUN DUE TO INCREASED QUANTITIES	$ 2 308		
UNDERRUN DUE TO DECREASED QUANTITIES	2 540		
NET CHANGE DUE TO QUANTITIES		$ 232	
OVERRUN DUE TO INCREASED UNIT COSTS	$ 7 120		
UNDERRUN DUE TO DECREASED UNIT COSTS	4 810		
NET CHANGE DUE TO UNIT COSTS			$ 2 310
OVERRUN DUE TO CHANGES IN PLAN	$ 1 932		
UNDERRUN DUE TO CHANGES IN PLAN	1 200		
NET CHANGE DUE TO CHANGES IN PLAN			732
	TOTAL	$ 232	$ 3 042
			232
	NET		$ 2 810
PERMANENT MATERIAL			
OVERRUN DUE TO INCREASED QUANTITIES	$ 1 760		
UNDERRUN DUE TO DECREASED QUANTITIES	2 470		
NET CHANGE DUE TO QUANTITIES		$ 710	
OVERRUN DUE TO INCREASED UNIT COSTS	$ 5 360		
UNDERRUN DUE TO DECREASED UNIT COSTS	6 870		
NET CHANGE DUE TO UNIT COSTS		1 490	
OVERRUN DUE TO CHANGES IN PLAN	2 240		
UNDERRUN DUE TO CHANGES IN PLAN	1 050		
NET CHANGE DUE TO CHANGES IN PLAN			$ 1 190
	TOTAL	$ 2 200	$ 1 190
		1 190	
	NET	$ 1 010	
SUMMARY			
LABOR			$ 2 810
MATERIAL		$ 1 010	
OVERHEAD			1 250
	TOTAL	$ 1 010	4 060
			1 010
NET TOTAL CHANGE			3 050
OFFICIAL ESTIMATE			$ 300 000
PROBABLE TOTAL COST OF PROJECT			$ 303 050

to uniformity on all projects. The weights for Progress are computed from the "Total" column in the "Cost Engineer's Estimate" of Table I.

The "Per Cent Cost To Date" is next computed by practically the same mathematical process as described for "Progress." The unit cost to date of each item is given in per cent of the unit cost of that item as set up in the Official Estimate. The weights are obtained by use of the total column in the "Official Estimate" of Table I instead of the "Cost Engineer's Estimate." Items which are not yet started are left blank, for we do not know if the cost will be greater or less than estimated. Hence, to obtain the per cent unit cost of the group, the sum of the products of the per cent unit cost times weight is divided by the sum of the weights of only those items which have been started. In our example 94.2 is the divisor and the unit cost for the group is 102.9%. The groups are combined to get a similar figure for the project as a whole.

The "Per Cent Unit Cost" thus obtained does not indicate that this group will cost in total dollars 102.9% of the total dollars given in the Official Estimate, because in obtaining it quantities are disregarded except as affecting weights. This figure is not intended to show total costs at all, as other forms are used for this purpose. But it is intended to be an indicator of the labor efficiency on the group and on the whole project. The titles "Per Cent Cost to Date" or "Per Cent Unit Cost" were used because they describe the procedure rather than the result. Other terms which suggest themselves for this figure are "Cost Index," "Unit Cost Index," and "Efficiency Index."

Similarly, figures might be computed for *material* costs, but where the Government is buying and furnishing most of the material to the contractor, such figures would serve no practical purpose.

Analyzing Cost Variation

After completing the computations described in Table II, the figures in the last two columns of Table I are analyzed by means of two other forms recast herein as Tables III and IV. These consider the causes underlying the Probable Cost Variation and obtain the amounts due to the different causes instead of considering them by trades or operations.

Table III also shows the total variation between the Official Estimate and the Cost Engineer's Estimate for all other parts of the work in addition to the group shown as 1 H. It gives the probable total cost of the project and enables the directors of the Corporation to plan accordingly.

The figures used in our hypothetical example for labor are carried through to this form without considering groups other than 1 H, so that the reader may easily follow the necessary computations.

The upper portion of Table II shows the result of this analysis of Table I. In this portion of Table III the same total overrun or underrun appears as in Table I, but the amounts which make the totals are different. The amounts are set up so as to show increases or decreases due to increased or decreased quantities, increased or decreased unit costs, and changes in plan.

The figures in the central and lower portion of Table III referring to material and to overhead are assumed herein as coming from other sheets of the report which are not shown in this example. The method of obtaining these figures is practically the same as herein described for labor. The totals also disregard all other groups in order to keep the example consistent.

Table IV shows the process of obtaining the figures for labor in Table III. The first column contains the

TABLE IV. AN ANALYSIS OF PROBABLE COST VARIATION TO DETERMINE THE CAUSES FOR THE VARIATION AND THE AMOUNTS DUE TO EACH CAUSE

This sheet is the intermediate between Tables I and III. It enables the cost engineer to compute almost automatically the six cardinal variations between the Contract or *Official Estimate of Cost* and the *Actual Cost*—Underrun (1) and Overrun (2) due to the corporation's changes are clearly separated from the four variations due to causes over which the contractor has control; viz., underrun (3) and overrun (4) due to incorrectly estimated quantities, and underrun (5) and overrun (6) due to decreased or increased unit costs.

Acct No.	Variation due to CHANGES IN PLAN by Corporation: A Quantity Decrease	D Quantity Increase	C Unit Cost $	D×A=C Product Underrun $	E−B=C Product Overrun $	Variation due to Incorrectly Estimated QUANTITIES by Contractor: F Quantity Off. Est.	G Quantity Cost Engineer's Estimate Included in Plan	H=F−G Difference Decrease	J=G−F Difference Increase	K Official Estimate Unit Cost $	L=H×K Product Underrun $	M=J×K Product Overrun $	Variation due to Decreased or Increased UNIT COSTS by Contractor: N Unit Costs Off. Est $	O Unit Costs Cost Eng. Est $	P=O−N Difference Decrease $	Q=N−O Difference Increase $	R Quantity Cost Eng. Est Included in Plan	S=P×R Product Underrun $	T=Q×R Product Overrun $	TOTALS: U=D+L+S Underrun $	V=E+M+T Overrun $	NET TOTALS: W=U−V Underrun $	X=V−U Overrun $
1-H																							
12.11																							
13.331	30		34.00	1 200		1 200	1 130	70		28.00	1 960		32.00	34.00	2.00		1130	2 260		3 260	2 260	1 000	
14.1		56	34.50		1932	1 300	1 344		44	32.00		1 408	32.00	34.50		2.50	1344		3360		4 700		1 340
14.3													120.00	135.00		15.00	100		1500		1 500		1 500
13.5				48 000	48 300	2 300			6.40	1 000			0.40	0.38	0.02		48 300	910		1 910		1 910	
14.													180.00	183.00	18.00		100	1 800		1 800		1 800	
27.1																							
			TOTAL	1 300	1932					TOTAL	2 360	2 308					TOTAL	4 810	7 120	4 560	11 160	8 350	2 810
					1 300						2 360												2 810
			NET		732					NET	252						NET				2 310		2 810

same classification numbers as are shown in the first column in Table I. The popular description column and the unit of measure column are not required on this sheet, as by referring to the same classification number on Table I, bound next to this sheet, this information may be found.

The first item to be separated from probable cost variation is the variation due to "Changes in Plan" which the Corporation makes. The dollars not chargeable to this cause are chargeable to causes over which the contractor has control, namely, incorrectly estimated "Quantities" and increased or decreased "Unit Costs."

In compiling Table IV, details which control additions or deductions due to changes in plan are obtained by an examination of the records concerning the contract and change orders. The amount of the decrease or increase in quantity is then inserted in either column A or B

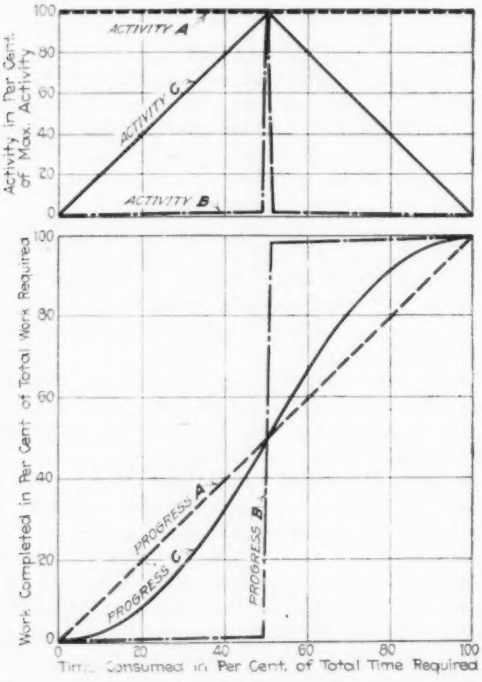


FIG. 2. RELATION BETWEEN ACTIVITY AND PROGRESS ON CONTRACT

as the case may require. In column C is inserted the unit cost. The product of the increased or decreased quantity by the unit cost is then inserted in either column D or E as required. It may be that the change order mentions no quantity or unit cost. In this case columns A, B and C are ignored and the total amount of dollars in the change order is inserted directly in column D or E.

After deducting all changes in plan, the cost engineer proceeds with the computations in the other columns *F* to *X*, inclusive. The figures to be inserted in columns F, G, K, N, O and R are obtained from Table I. Columns G and R may be modified by the figures in columns A to E.

After inserting the proper figures, the cost engineer performs the operations indicated by the headings of the columns. If he makes no mistakes in computations the net totals of columns U and W, or V and X, must be the same amounts as the total "Probable Variation" column in Table I. This provides an automatic check on the mathematical result. The totals are then transferred to the proper spaces in Table III.

This completes the mathematical analysis of progress and cost for the report.

Uniform Progress Not Expected

When progress is reported in per cent of actual production, it should be remembered that the per cent of production need not correspond with the per cent of time elapsed at the date of the report. In fact, on housing work exactly the contrary may be expected at all times except at one intermediate point and at the end of the work. This is especially true for main groups and for a whole project.

It is axiomatic among engineers that construction is slow in starting and slow in finishing. If this means that daily production in per cent of the whole is less at the beginning and at the end of the time required for construction than the daily production near the middle of this time, it is logical that it should be true. On most buildings the excavating must be well under way before the foundations can be started. There is a period at the beginning when no trade but excavators may be worked. When the foundations are started there are two operations or trades being worked. As the construction proceeds other trades are started in an orderly way, such as framing, superstructure masonry, plumbing, wiring, etc. Ultimately there are many trades working simultaneously, but some of them have to be nearly finished before others can begin. Thus, there is a period when a maximum number of trades may be worked simultaneously. This may be termed the period of maximum activity. This period is generally near the middle of the time required for the whole work, and ordinarily the rate of production at this time also becomes a maximum. From this point forward the activity diminishes until finally production is confined to completing certain odds and ends, and to final cleaning up.

Referring to Fig. 2, activity is represented on the upper part of the diagram and progress on the lower portion. Activity may be measured by the number of men working daily, or, better, by daily payrolls. Again, assuming that men are paid in proportion to what they produce, it follows that activity may be translated into progress based on production. One extreme assumption for activity is that the work starts with the maximum number of men possible and continues with this force until the work is complete. Such activity is represented by the activity curve A. The resulting progress is indicated by the straight line marked progress A and may be termed uniform progress. This condition cannot occur on an extensive building operation, but some of the individual trades will approximate it. The other extreme is represented by the activity curve B. In this case a very small force is used on preparatory work, producing very little for a long period. This force is suddenly expanded to a maximum for a very brief period, during which time nearly all the work is done. Then follows a long period of small activity and small production. Such a condition will probably never occur in extensive construction operations. A mean between these extremes is represented by the activity curve C. In this case construction is started with a minimum force which is uniformly built up to the maximum at the middle of the construction period and is then uniformly reduced to zero at the end of the

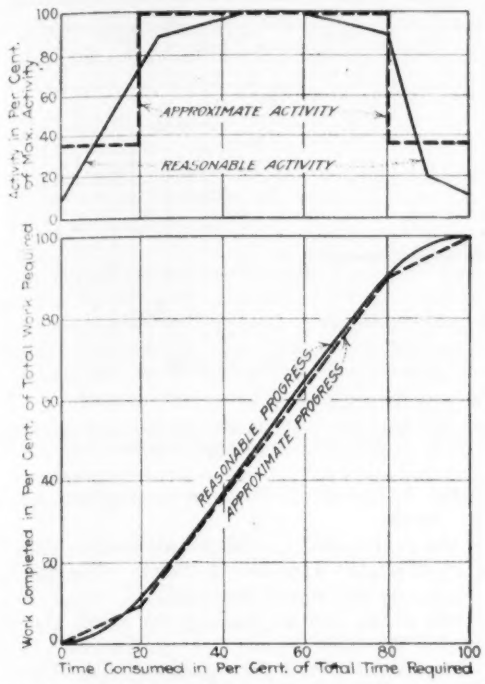

Activity in Per Cent. of Max. Activity
APPROXIMATE ACTIVITY
REASONABLE ACTIVITY
Work Completed in Per Cent. of Total Work Required
REASONABLE PROGRESS
APPROXIMATE PROGRESS
Time Consumed in Per Cent. of Total Time Required

FIG. 3. DIAGRAM SHOWING ACTIVITY AND THE PROGRESS EXPECTED

working time. The resulting progress is a reverse curve as shown. The two C curves represent actual conditions on large building operations more nearly than either of the others, but such an activity curve is not altogether rational.

Because there must be some force employed at the very start as well as at the end of the working period, the activity curve cannot actually start or stop at zero. Activity is generally maintained for some length of time at nearly the maximum rate instead of culminating in a distinct peak. Maximum activity will ordinarily occur near the center of the construction period, but in special cases it may be near the beginning or near the end. These curves serve to give a good idea of the progress that should be expected on various operations requiring different organization methods.

In a general way, on housing projects it is deemed reasonable to expect that the working force should be built up from a nucleus of about ten per cent of the whole at the beginning to nearly the maximum force when twenty-five per cent. of the allowable time has expired, and that the maximum should occur during the period from forty-five to sixty per cent., but nearly the maximum should be maintained until eighty per cent. of the allowable time is gone. The force is then reduced rapidly to the size required for completing odds and ends and for cleaning up.

The curves for this force are shown on Fig. 3 and marked "Reasonable Activity" and "Reasonable Progress." Referring to the progress curve, it will be noted that when twenty per cent. of the working period has expired, about ten per cent. of the work, measured by actual production in place, should be completed, and that when eighty per cent. of the time is gone, ninety per cent. of the work should be completed. Hence, the curve is fairly closely approximated by the line labeled "Approximate Progress."

Each project should be studied—by establishing whether the houses are all to be carried forward simultaneously or in a series of groups; by estimating the sequence in which the various trades will take up their work, and by estimating the effect the utility construction will have on the whole undertaking—to fix a reasonable progress curve to use as a target. But in the absence of such a study, the approximate curve just mentioned serves fairly well for housing projects.

Individual trades or operations exhibit to some extent the same tendencies as do combined operations in that they have their getting-ready and finishing-up periods. Considerable experience is required to fix properly target progress curves for individual trades. The straight line of uniform progress is quite satisfactory for most trades if it is remembered that some lagging behind during the early stages is not a matter of great concern, but that in order to complete on time, production must be well ahead of the uniform progress during the late stages.

Visualizing the Tabular Records

For the purpose of making the more important information contained as tabular matter in the reports available with a minimum of mental effort, suitable diagrams are employed. A few of these charts containing worthy features will be described.

The method of visualizing progress and costs of various trades is illustrated in Fig. 4. This specific chart is made for face brickwork in our example. The diagram reads horizontally in months and days, and vertically in number of brick, per cent., and dollars. This

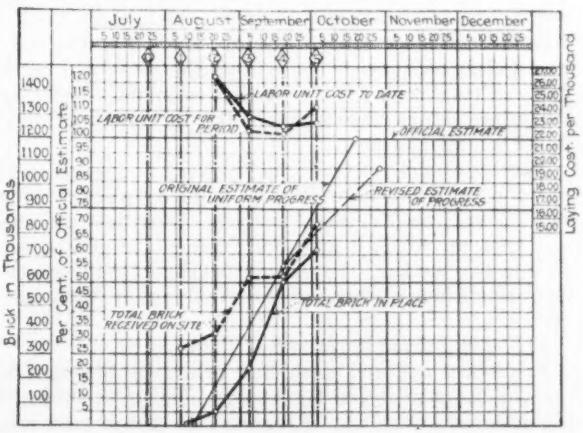


FIG. 4. TRADE PROGRESS CHART SHOWING LABOR UNIT COSTS FOR PERIOD AND TO DATE

Also shows quantities and percentages of material (brick in the case of this diagram) received on site and in place

diagram is computed from the information contained on the second line of Table I and the same line of previous reports. The date of beginning of the project is indicated by the verticle line with the 0 in the diamond at the top. As each report is made, the date of the report is indicated by a similar vertical line, with the report number at the top. It will be noted that the number of brick in place and the number of brick received both read in per cent. of the number estimated and in the actual quantity. The costs for laying also read in per cent. of the estimated cost and in actual dollars per thousand.

It is desirable for progress of trades to watch receipt

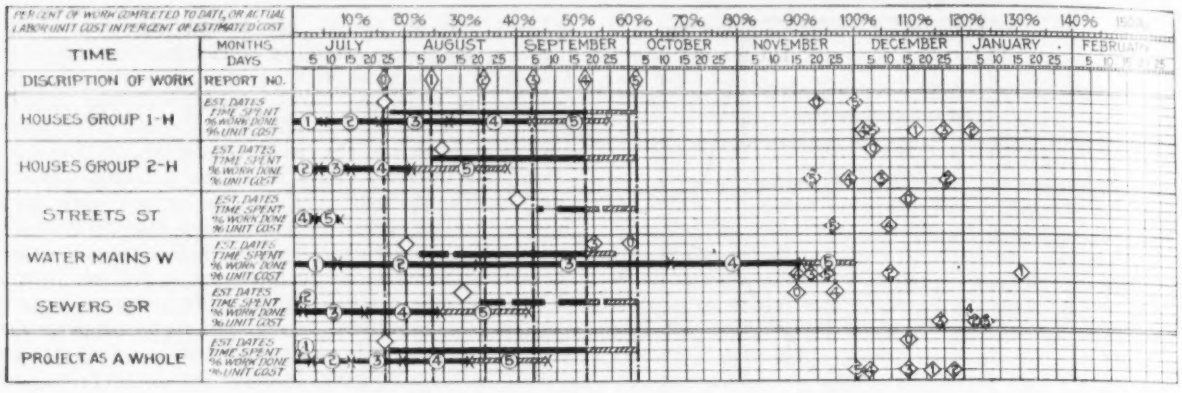


FIG. 5. GENERAL PROGRESS AND LABOR COST CHART

The information on this chart is a visualization of the general information contained in the report. Progress and cost are given for the main groups of the work as well as for the whole project. All reports to date are shown separately and collectively, and the future is predicted

of materials as well as the rate of incorporating them into the structure. In the example a delay in receipt of brick due to faulty shipments has caused a revision of schedule and is adversely affecting the laying costs. When the cost engineer advanced the time schedule on the chart, he also incorporated the estimated savings in quantity of brick required. The line labeled "Revised Estimate of Progress" indicates the resident cost engineer's expectations at the time the fourth report was made, and as no further revision is given for the fifth report, it must be assumed that he still expects to fulfill the new schedule. It will be noticed by studying the line of "Total Brick in Place" that the supply on hand will be quickly exhausted and that unless more brick is received another delay will result. Also, it will be noted that unless progress is speeded up the work will not be done on time even for the revised estimate. The chart therefore clearly shows that delay in receipt of brick upset all calculations.

Similar charts are made for the very important items and for those which, on account of unsatisfactory progress or cost, need detailed analysis. For field use they are kept up to date at more frequent intervals than once in two weeks. The tracing is kept at the field office and blueprints forwarded to Washington with each report.

Fig. 5 is a graphic resumé of the report.

A vertical dot and dash line is drawn through the date of the report and the report number is shown in the diamond at the top. Progress and cost of each item are indicated on the four horizontal lines which run to the right from the item. On the first and second lines the quantities are read in months and days and on the third and fourth lines in per cent.

On the first line the original estimate and the revised estimates of dates of beginning and completion are shown. A blank diamond indicates original estimate of date of beginning and a diamond with 0 in it indicates original estimate of date of completion. The numbers in the other diamonds indicate the report number on which the revised estimates were made.

On the second line the actual time spent on the work is shown by a very heavy line. Interruptions are shown by breaks.

On the third line the percentage of work completed on the date of the report is shown. The percentage completed at the end of all previous report periods is indicated by crosses. The report numbers are given in the circles.

On the fourth line the labor unit cost to date in per cent. of estimated unit cost is shown. The numbers in the diamonds are report numbers.

To add to the ease of reading, the chart, the lines or marks for the latest report are colored red. In Fig. 4 the cross-hatching and the diamonds with corners only represent red.

The chart shows in compact form the status of all the main groups and of the project as a whole, from the beginning of construction to the date of the current report. Whether progress is getting better or worse and whether labor unit costs are improving or retrograding is apparent at a glance.

Fig. 6 is a chart showing progress and cost of the project as a whole. The information given is practically the same as that shown for the last item of Fig. 4, but is in a form more familiar to the average reader.

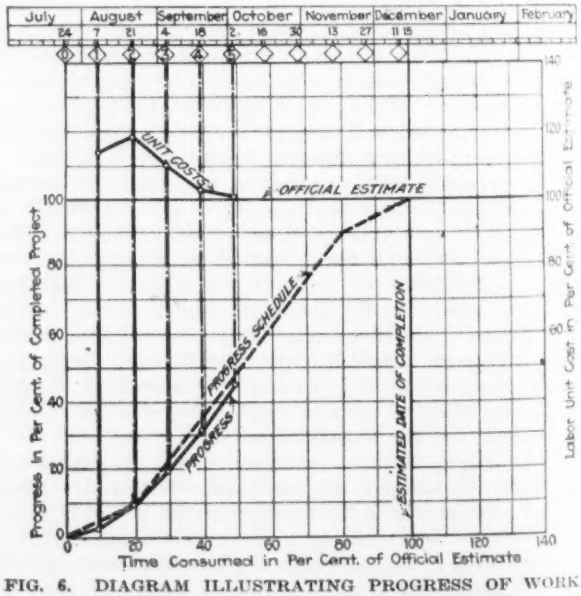


FIG. 6. DIAGRAM ILLUSTRATING PROGRESS OF WORK AND COSTS OF LABOR UNITS EXPRESSED IN TERMS OF CONTRACT

A collection of these charts provides, in compact form, a series of terse statements of the progressive physical conditions and costs of all projects. These charts may be termed the indices of the performances of the contracts.

A collection of these charts, one for each project, is kept on the desks of all persons interested in following progress and costs. The curves are compiled for labor only.

A plat of the entire property with various stages of completion of all buildings and utilities, indicated by means of cross-hatching and coloring familiar to all engineers, is included with the report.

After all sheets have been checked, the cost engineer studies them from the point of view of the man in the office perhaps three thousand miles away. He then dictates the letter of transmittal. This is a terse statement explaining everything the cost engineer deems the Corporation should know in connection with the report. High or low costs, speed or lack of it, shortage of labor or material, the weather, the personnel of the organization, and many other items require consideration in analyzing reports. The cost engineer is the one person whose duty it is to watch, record, analyze and report performance, so that those at headquarters may know

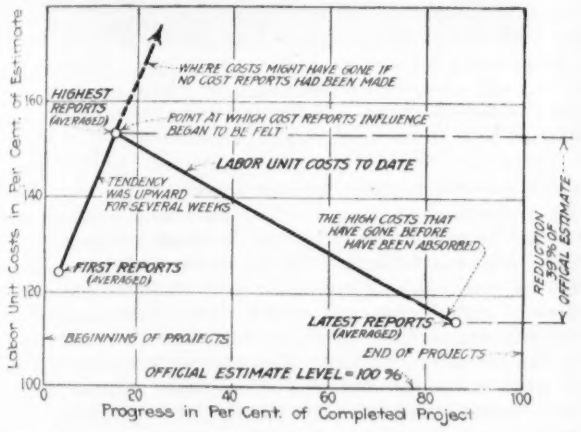


FIG. 7. DIAGRAM ILLUSTRATING REDUCTION IN LABOR UNIT COSTS

the accomplishments almost as well as if personally present.

All sheets composing a report are bound in a prescribed order into manila letter-size vertical file folders. Standardized information is given on the face of the cover.

The proof of the usefulness of any cost-reporting system can be found only by an examination of its actual operation.

Fig. 7 shows in a general way how labor unit costs compared with estimates have progressed on all the projects averaged into a composite. The reduction of thirty-nine per cent. is further analyzed in the following paragraph.

An examination of the cost curves similar to the upper curve on Fig. 6, for all projects, shows that the projects, as far as labor unit costs are concerned, group themselves into four general classes: (1) Those in which the course of costs is upward for some weeks, followed by a long period of improvement; (2) those which have shown a steady improvement from the very beginning; (3) those on which the costs have run about horizontally, showing neither improvement nor retrogression, and (4) those in which the costs have grown steadily worse. The majority are in the first class and the next largest number are in the second class. Only a very few are in class 4. The sum of the savings represented by the reductions in costs for Classes 1 and 2 is several million dollars, which is many times the cost of maintaining the cost engineering section. This reduction was effected without reducing labor wages and in many cases was made in spite of increased wages.

It should be understood that the cost engineering section did not actually install improvements in the construction organization, as this was done by the manager of the construction division, but the cost reports have been an *index* to the specific parts of operations that required attention and action. They have enabled those responsible for the construction to concentrate on the items which reflect unhealthy conditions and to pass with a word of commendation over those which were proceeding normally. The progress and cost reports may be regarded as the diagnosis of a project which permits the manager and his works superintendents as the physicians to apply proper medical measures immediately. Without a reliable and prompt diagnosis the patient's condition might become serious while the doctors are experimenting with the various remedies.

It may be argued that the costs would have come down even if no records had been kept. We are free to admit that some of them probably would have done so. But against this argument, we are sure any person familiar with war-time construction will say that if no check is kept on construction costs, the chances of the costs going upward are greater than of their coming downward.

It is a significant feature that in a majority of the projects unit costs went upwards for a few weeks and then reversed, since which time they have come steadily downward. This is explained by the fact that it took a short time to have the cost reports coming in properly and to set the necessary machinery in motion for correcting the difficulties.

The argument that unit costs at the start are always the highest is refuted by this class of curves, for they show that the costs continued to mount until corrective steps were taken. The few projects in Class 4 where costs have continued to go up from the beginning, as well as those in Class 4, were the costs continued horizontally, also contradict this argument.

In addition to the other objects for which the reports were designed, it was intended that the data gathered by the cost engineering section should serve as the foundation for future estimating. This use was never realized, due to the early ending of the war. This suggests the fact that many contractors regard acquirement of bidding data as the only purpose of their cost-keeping system. Hence, their costs for the most part are compiled after the job has been completed. The expense of gathering cost data is scarcely justifiable unless the information is compiled promptly enough to point the way to immediate savings as the work progresses.

While the system just described was designed as a war measure to meet special conditions surrounding construction on a large scale, the principles are no less applicable to peace-time construction. With only minor modifications this system may be made to fit a great variety of building and industrial operations. It is difficult to see how any large undertaking can be successfully managed without some means of determining reliable progress and costs as the work proceeds. Because of prevailing high prices of material and labor, it is now of greater importance than ever before to inaugurate *efficient management*.

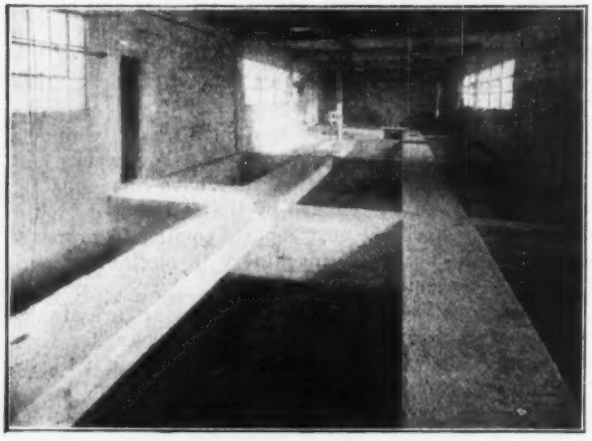
Concrete Used in Boiler-House Structure and Fittings

War Scarcity of Metal Led to Wide Application of Concrete in Brooklyn Navy Supply Base Heating Plant

By George S. Nobles
Turner Construction Company, New York City

COAL hoppers, forced-draft air duct, and boiler breeching, at the boiler plant of the Navy supply base, Brooklyn, N. Y., were constructed of concrete because of the difficulty in obtaining the customary metal during the war period in which the buildings were erected. The structures themselves were also of reinforced concrete, but were not of exceptional design, except that for the height of the first-story columns, 24 ft., and the 46-ft. height of the boiler room, which required scaffolding all the way up for the purpose of erecting and stripping forms.

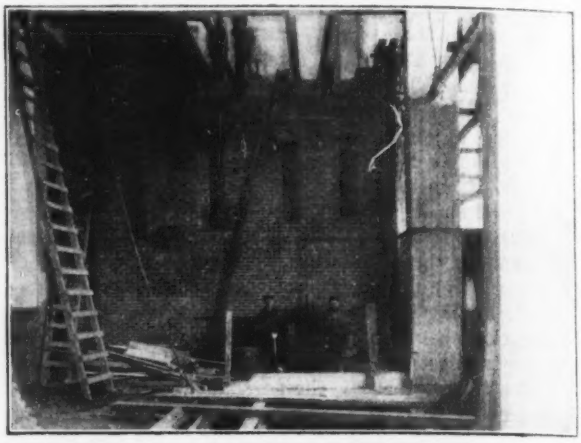
The power house is a complete heating plant. In brief, there are six 500-hp. boilers of the horizontal water-tube type. The feed water, which is taken from a 4-in. cold-water line, is passed through three pumping



MONITOR OVER COAL HOPPERS ALL BUILT OF CONCRETE

engines and forced by them to the fuel economizers, which are located about 36 ft. above the boiler-room floor and in back of the boilers. From there the water returns to the direct feed into the boilers. Since there is very little exhaust steam in a straight boiler heating plant, and also because the little that is there is largely utilized for the operation of turbines for forced draft, feed pumps, automatic stoker, conveyors, etc., it was not possible to operate the number of hot-water feed tanks which would be customary with 3000-hp. installation of boilers. Therefore, a hot-water feed tank of only about one-sixth this capacity was installed, and piping was so arranged as to provide for a bypass, so that only a portion of the feed water would pass through this tank.

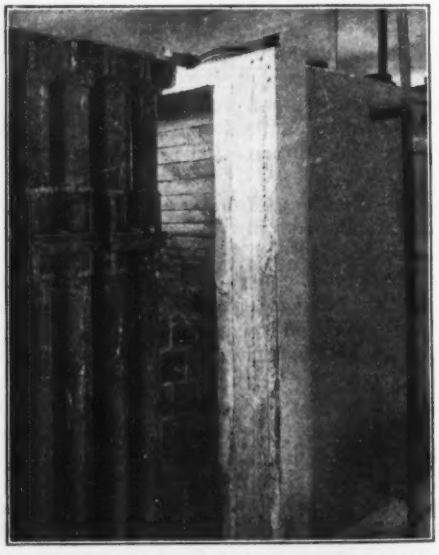
As indicated above, the plant is also equipped with a forced-draft system operated by three 2200-r.p.m. turbine direct-driven blowers. The coal, which is delivered through a hopper and a crusher outside the building, is carried to the storage bins above by an elevator and a conveyor, whence it is automatically discharged into weighing scales and thence through chutes into automatic stokers. The question of disposal of ashes



SIDE VIEW OF FIRST BATTERY OF BOILERS COMPLETED

is solved by the equipment of the stokers with automatic steam dumps which lead the ashes into bunkers below the boiler-room floor, whence they are discharged into a hand-dump car and carried to the ashpit. From this pit an ash elevator carries them to a bunker above at the coal-hopper level. Discharge from this bunker is effected by a chute into freight cars outside.

There are several special features of the building which present possibly greater interest even than did the mechanical equipment. The duct in the basement for the forced-air draft system is constructed of concrete, with connections to the fireboxes made of plaster laid on metal lath, the only portion of this duct made of sheet metal being that section directly adjoining the blowers, where, since it is necessary to include a damper, the metal is essential. The coal hoppers, about 22 ft. wide at the top and 45 ft. deep, with a capacity of 2000 tons of coal, are also constructed completely of

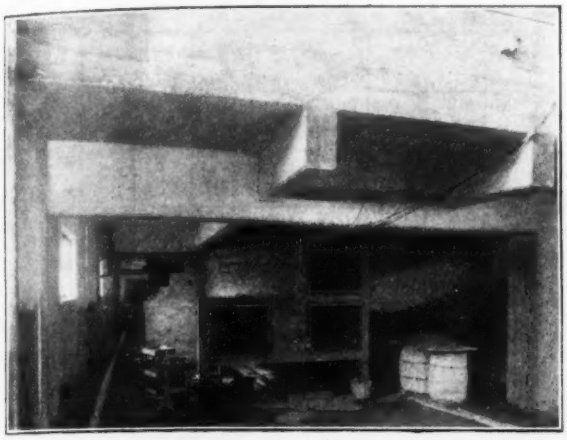


FUEL ECONOMIZER AND CONCRETE BREECHING ADJOINING

concrete. They are of the typical trapezoidal hopper section. In the lower portion, where, it was anticipated, the grinding effect of the coal would be more pronounced, a little metallic hardener was used in the con-

crete. The ash bunkers in the basement were likewise made of concrete.

The section of the building in which the use of concrete is more or less of a novelty is the boiler breeching, which is usually constructed of sheet metal. Here concrete is used throughout. The breeching is about 36 ft. high; the wall thickness is 4 in., increasing to 6 in. at some points, and it was built in six separate expansion sections. Sheet-metal expansion joints are placed between the metal faces of the economizers and the adjoining concrete walls. Where the heated gases of combustion enter the breeching through smoke hoods from boilers, the concrete ceiling has been plastered with about a 1-in. thickness of a special retort cement, and at all other places, bottom and sides, it is lined with tile. A very neat and thoroughly workmanlike job results, and there is every reason to believe that this concrete breeching wall will serve the purpose for which it is intended as well or even better than would one of a sheet steel. The work was done in the summer of 1917 and 1918 by the Turner Construction Co., of New York City, under the direction of the United States Navy Department.



END VIEW OF FORCED-DRAFT DUCT BUILT OF CONCRETE

The three openings are for connection to turbine blowers; at the right the plaster-on-lath air feed to firebox of first battery of boilers.

Water-Power Studies in India

As a start toward a hydrographic survey of India a Government study of the water-power possibilities of the country is being made. G. T. Barlow, chief engineer for irrigation, and John W. Mears, electrical adviser to the Indian Government, Simla, are inspecting possible power sites for the purpose of selecting those that are considered worthy of detailed investigation by the Government.

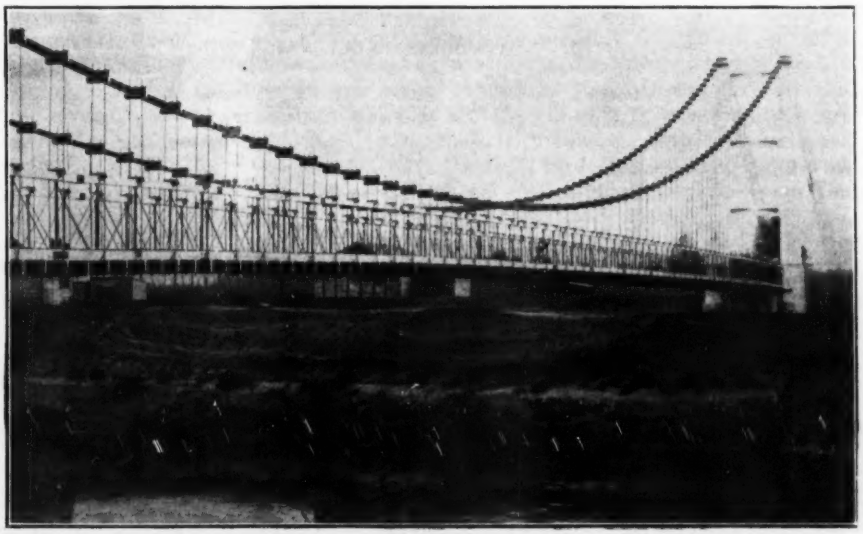
Longest Suspension Bridge in New Zealand

BY O. JOHNSON
Donnevirke, New Zealand

TO BE used mainly for the purpose of transporting flax-carrying trucks, the longest suspension bridge in New Zealand, 473 ft. over all, was completed under war conditions in about one year at a cost below £6 per running foot of bridge, including all engineering expenses. It is located about nine miles from Palmerston North, on the Foxton line, and crosses the Manawatu River. The cables are of the best plow steel, 16 in number on each side. The total length of each cable is 750 ft.; the cables are carried over the tops of the towers on saddles resting on 24 wheels, and each cable has a breaking strain of 60 tons. They are fastened to the anchorages by 2-in. rods about 30 ft. long and steel channels.

ROADWAY OF NEW ZEALAND SUSPENSION BRIDGE

The suspender rods are double, of ⅝-in. diameter, and fixed to the cables with strong clips. The length of these rods varies from 48 ft. to 8 ft. The stiffening truss is 4½ ft. deep with 7 x 5 in. and 5 x 5 in. chords, all timber being black birch. Vertical rods, each 3½



SUSPENSION BRIDGE AT LOW COST BUILT OVER MANAWATU RIVER, NEW ZEALAND

ft. long by 1⅞ in. in diameter are used, with ⅝-in. diagonal rods for the web members. About 30,000 ft. board measure of timber was required; the floor joists are 9 x 4 in. and 9 x 3 in., and the decking is 8 x 2½ inches.

The anchors and towers are reinforced concrete, the height of the towers from foundations to top of saddles being 68 ft. As illustrated in the photograph, the two towers at each side of the river are connected by three horizontal reinforced-concrete struts of arched outline. The anchorages contain about 20 cu.yd. of concrete each, in which the 2-in. anchor rods are embedded.

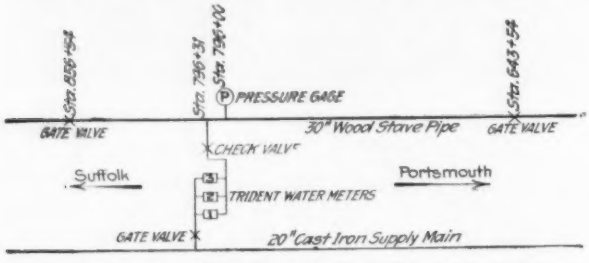
This bridge was built for the Tane He mp Co. by Joseph Dawson of Pahiatua, New Zealand.

Leakage Test of Wood-Stave Pipe Line

By Victor M. Crown

Civil Engineer, Portsmouth Water Development, Quartermaster Corps, United States Army, Suffolk, Va.

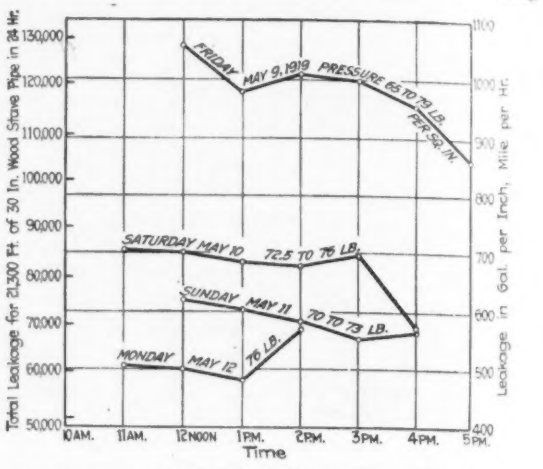
TEST data on leakage in a 30-in. continuous wood-stave pipe are shown in the accompanying table and diagram. The pipe is part of a supply main installed between Suffolk and Portsmouth. Fortunately, a supply of water for the test was near at hand in a



SKETCH MAP SHOWING CONNECTIONS FOR TEST

20-in. cast-iron main that paralleled the wood pipe.

The following description of the test will be made clearer by reference to the sketch map. By means of gate valves the wood-stave pipe line was closed between Sta. 643 + 54 and 856 + 54, a distance of 21,300 ft. Water was supplied at Sta. 796 + 31 from the 20-in. cast-iron main and measured by three disk meters arranged in parallel. Simultaneous readings were taken of the meters and pressure gage on four successive days, at intervals of one hour. Readings were reduced to a unit basis so as to be applicable to a pipe of any length and diameter, and the result was noted in column 9 on the data sheet. Leaks were being



LEAKAGE CURVES IN WOOD-STAVE PIPE TEST

repaired during the test, which accounts for the decrease from 1070 to approximately 500 gal. per inch-mile in 24 hours.

At this latter figure no further leaks were discernible and the pipe was accepted by the constructing quartermaster.

Government Wireless Stations

The United States Government has erected wireless plants at various points along the Atlantic and Pacific coasts and at Pearl Harbor, Hawaii, and at Cavite, in the Philippines. Government shore stations, according to the reports of the Bureau of Navigation, numbered 135, on June 30, 1918, of which 88 were in the continental United States, 20 in Alaska, 19 in the Philippine Islands, 3 in the Canal Zone, 2 in Hawaii, and 1 each in Porto Rico, Guam and Samoa. The Government ship stations totaled 470.

DATA OBTAINED IN LEAKAGE TEST OF WOOD-STAVE PIPE

Time	P Pressure in Pounds per Square Inch	$h = 2.3\,P$ Equivalent Water Head in Feet	Meter No. 1 Cu.Ft.	Meter No. 2 Cu.Ft.	Meter No. 3 Cu.Ft.	Leakage Cu.Ft.	Leakage Gal.	L Gallons per Inch-Mile per 24 Hours	L_{24} Total Leakage in 24 Hours, Gallons
Friday, May 9, 1919									
Start 11:00 a.m.	65	150	2,872	237	2,622				
12:00 noon	78	180	3,122	466	2,863	720	5,380	1,070	129,000
1:00 p.m.	78	180	3,352	673	3,084	658	4,930	980	118,000
2:00	79	183	3,586	892	3,308	677	5,070	1,010	122,000
3:00	78	180	3,816	1,109	3,531	670	4,940	1,000	118,000
4:00	78	180	4,037	1,317	3,744	642	4,800	955	115,000
5:00	75	173	4,239	1,505	3,934	580	4,340	863	104,000
Saturday, May 10, 1919									
10:00 a.m.	74	171	7,478	4,545	7,045				
11:00	72.5	167	7,642	4,699	7,201	474	3,540	705	85,000
12:00 noon	73	169	7,812	4,840	7,360	470	3,520	700	84,500
1:00 p.m.	74	171	7,980	4,996	7,498	462	3,460	685	83,000
2:00	76	175	8,146	5,151	7,635	458	3,360	680	80,500
3:00	75	173	8,298	5,297	7,803	466	3,500	695	84,000
4:00	72.5	167	8,438	5,427	7,917	384	2,880	570	69,000
Sunday, May 11, 1919									
11:00 a.m.	73	169	11,289	8,125	10,698				
12:00 noon	72	166	11,435	8,257	10,836	416	3,120	620	75,000
1:00 p.m.	72	166	11,577	8,387	10,972	408	3,060	606	73,500
2:00	71	164	11,711	8,513	11,104	392	2,940	583	70,600
3:00	70	161	11,841	8,633	11,226	372	2,780	553	66,800
4:00	72	166	11,971	8,757	11,354	382	2,860	568	68,600
Monday, May 12, 1919									
10:00 a.m.	76	175	14,161	10,780	13,423				
11:00	76	175	14,278	10,893	13,537	344	2,580	512	62,000
12:00 noon	76	175	14,392	11,005	13,649	338	2,530	503	60,800
1:00 p.m.	76	175	14,496	11,125	13,759	324	2,430	482	58,500
2:00 p.m.	76	175	14,626	11,249	13,337	382	2,860	568	68,600

Track Elevation on the Indianapolis Union Railroad

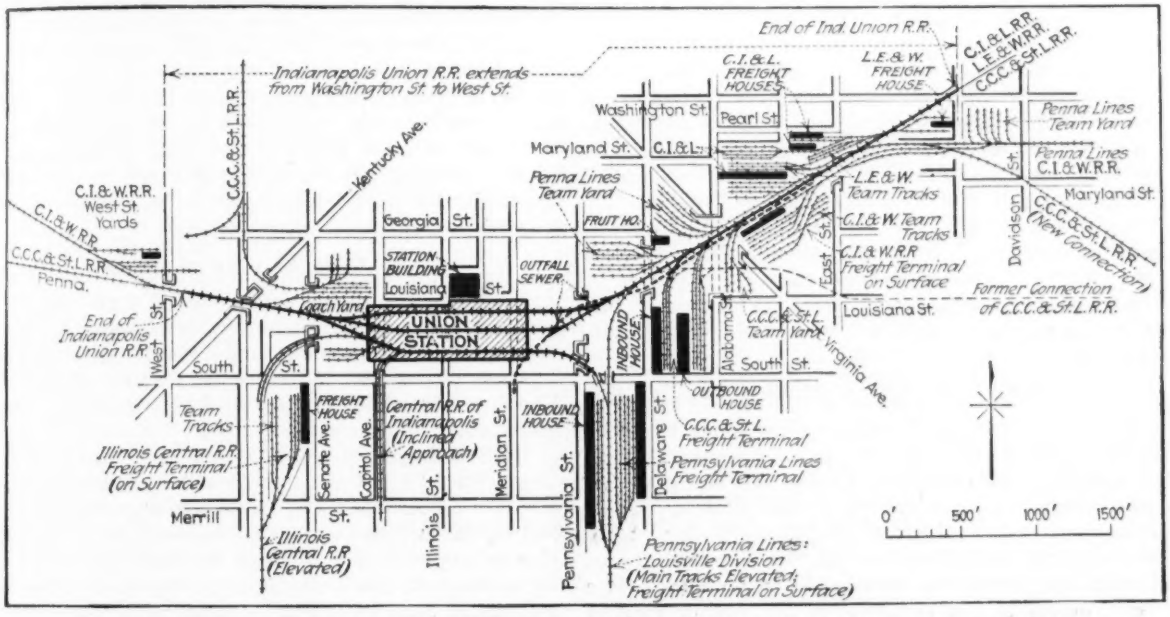
Traffic of 165 Trains Daily Necessitates Piecemeal Methods of Track Elevation on Line Through Union Station and Connecting Two Groups of Railways—Tracks Raised 18 Feet—Large Outfall Sewer Rebuilt

TRACK elevation for the elimination of grade crossings at Indianapolis, Ind., is an $18,000,000 project extending over several years and involving main lines, a connecting line across the business section of the city, a busy union station and a group of freight terminals, together with street and sewer alterations and other auxiliary works.

The most serious part of the problem, involving 50% of the total cost, is the elevation of the Indianapolis Union R.R., a 1¼-mile line which carries all passenger traffic through the city and on which the union station is located. The solution was aided by the widening of the line and the station yard, so that some beginning could be made before there was interference with existing facilities, but all work had to be under heavy traffic. Bridges replace 11 grade crossings, four of which were near the station and extended over a series of tracks in continual use. Elevation and revision of several freight yards located along the line form an important accessory to the improvement, but this work was done by the trunk lines which own the terminals. The reconstruction of the union station was described in *Engineering News-Record* of July 10, 1919, page 84.

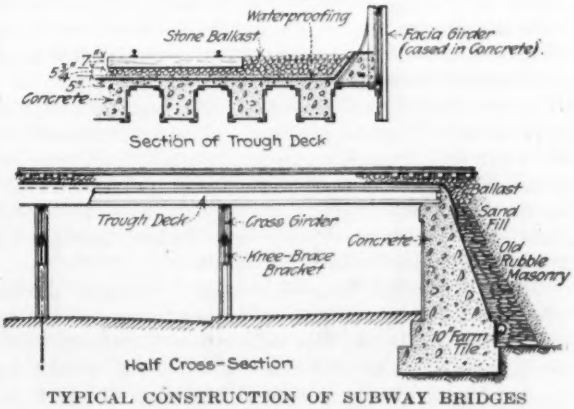
Indianapolis is a great railway center, and is peculiar in that the numerous railways converge upon the ends of the 1¼-mile line noted above, as shown by the accompanying map. Four railways have nine divisions connecting with the west end, while five railways have eight lines connecting with the east end. Two junctions are just outside the station. Traffic, therefore, is not only very heavy, but is complicated by numerous switching movements at the station and at the freight terminals. An average of 165 passenger trains daily are handled at the station, besides about 60 freight movements. These latter are mainly for industry connections, as regular freight trains are passed around the city by the 14-mile belt line of the Indianapolis Union R.R., which provides interchange between the railways and their main yards and also serves a number of outlying industries.

Full elevation of tracks was adopted in place of the compromise method of partial elevation combined with street depression. There is very little lowering of the streets, and their approach grades will not exced 3%. The tracks are elevated about 18 ft., so as to give a minimum headway of 12 and 14 ft. where there are no car tracks and 15 ft. 9 in. where clearance must be provided for cars of electric interurban railways.



TRACK ELEVATION THROUGH INDIANAPOLIS INVOLVES UNION STATION AND FREIGHT TERMINALS

Steel bridges over the streets are of the trough-floor type, carrying a concrete deck for the ballast and supported by steel bents at the curbs and in the roadway. For the long subway at Meridian St., just outside the station, deck girders will span the roadway and carry a buckle-plate floor with concrete slab. Concrete casing is applied to the facia girders of all bridges. Owing to the restriction on steel supply during the war, timber



TYPICAL CONSTRUCTION OF SUBWAY BRIDGES

trestles were erected in some places to connect with the first elevated tracks of the station and so permit their being put in service. Retaining walls and abutments are of plain concrete, as described in the earlier article on the station work.

The placing of the fill is a difficult part of the work, on account of the almost continual traffic, the numerous junctions and yard connections and the switching movements for passenger and freight service. Work trains increase the congestion from the fact that certain running tracks must be given up to them temporarily while material is being dumped and track raised on the fill. Some of the elevation on the main line beyond the station is done by successive small shifts; material is dumped, the train is moved away and the track is jacked up to have the material shoveled under it in readiness for the next lift.

On the more open part of the line the widening for two additional tracks was done in advance of interference with the two original tracks. But near the station, with its complicated approaches, the work had to be done piecemeal in short sections and as tracks could be given up to the construction force. No definite program could be made for any long period, as the necessity for handling late trains or unexpected movements was likely to interrupt the program. The location of work and the selection of tracks was planned by cooperation of the engineer in charge and the train dispatcher.

Filling Done by Railway Force

Owing to these traffic conditions, the filling was done by the railway. Gravel trains of 20 dump cars of 12-yd. capacity were brought to a point near the work, beyond which only a few cars at a time could be handled on account of lack of room and the short time during which tracks could be given up for the work trains. Contractors' dump cars were employed for most of the work, owing to the embargo on the use of gondola cars. For the same reason, some filling on the track elevation of the connecting main lines was done with 20-yd. and 28-yd. dump cars owned by these roads.

Progress has been hampered by war conditions, labor shortage, car embargoes and restrictions on supply of material. At the end of 1917, the United States Railroad Administration proposed to suspend the work, but a special representative sent to study the situation recommended that it be continued, in view of the serious interference with street and railway traffic consequent upon the incomplete conditions. Eight elevated tracks at the station will soon be ready and connected with the approaches. Work for 1919 includes elevating the remainder of the station tracks and a double-track approach at the east.

In the final layout the Union R.R. and both station approaches will have four tracks. Train movements will be controlled from three interlocking plants, two of which will be at the ends of the station. The third will be further east, serving the junction with the trunk lines and the connections to the freight yards. All tracks will be laid with 100-lb. rails.

Street traffic has been interrupted seriously during the work. The union station crosses three streets, one of which, Illinois St., has been closed to vehicle traffic since June, 1916, so that this traffic has had to use the long and busy grade crossing at Meridian St. or an inconvenient crossing at Capitol Ave. Formerly a low-level subway carried Illinois St. and its car line beneath the station, but this year the street is to be reopened at normal grade, passing under the elevated station.

An open storm-water channel and sewer outfall 40 ft. wide, known as Pogue's Run, was a troublesome factor, as it paralleled the main line and passed under the station. It was spanned at some points by girders carrying signal towers and cabins for watchmen at crossings. This has been replaced by the city with a double-barrel reinforced-concrete sewer having two compartments 18 ft. wide and 8 ft. high. At the station this is carried under Meridian St. instead of through the adjacent block, the abandoned section being filled up. As the new sewer passed under six streets crossed by the elevated tracks, steel bents were installed at these points to form supports for the abutments and columns of the subway structures. These bents straddle the sewer and have footings below its invert level. This sewer was described in *Engineering News* of Nov. 15, 1914, p. 935, and in *Engineering Record* of May 1, 1915, p. 560. Its cost was $1,079,853, of which the city paid $732,805, this being applied on its share of the track-elevation expense.

Total Cost Will Be $9,000,000

Work on this line was commenced in 1915. Its total cost, including reconstruction of the station, was estimated at $6,000,000, but with the war increase in price of material and labor it is expected to reach $9,000,000. The expenditures up to the end of 1918 had been about $4,000,000.

The Indianapolis Union R.R. is owned jointly by the Pennsylvania Lines and the Cleveland, Cincinnati, Chicago & St. Louis R.R., but its charter provides that any railway is entitled to use this line and the union station on payment of a share of the operating expenses. On account of this ownership, all improvement plans are passed upon by a board of engineers composed of W. C. Cushing, chief engineer of maintenance of way of the Pennsylvania Lines; C. A. Paquette, chief engineer of the C., C., C. & St. L. R.R., and P. J. Landers, superintendent (and formerly engineer) of the Indianapolis Union R.R. Construction work is in charge of T R. Ratcliffe, engineer of maintenance of way.

Grade-Crossing Elimination at Indianapolis

History Reviewed—Elevated Tracks Replace Street Viaducts—Freight Terminals Affected —Total Cost $18,000,000

GRADE separation in Indianapolis, as in several other cities, began with viaducts to carry streets over the tracks, but it was soon evident that these would afforded only partial relief. The only one remaining when track elevation was commenced was that at Virginia Ave. This was built in 1891 and was 500 ft. long. For several years it was in bad condition, but it was shored up for temporary service, as it carried an important street-car line across a series of tracks. It was demolished in 1919 to make way for the new Virginia Ave. subway.

Track-elevation history began in 1898, when the city engineer, Mr. Jeup, was directed by the council to pre-

pare plans. Then came a period of controversy. Acting on the basis of these plans, the city, in 1899, passed an ordinance declaring all steam tracks at grade to be nuisances and requiring the railway to elevate them. The city was divided into districts, with dates set for the completion of work in each. In April, 1900, the railways were directed to remove or elevate their tracks in the first district by September, 1901. As they refused to do this or to recognize the authority of the city, suit was brought against them, but the decision was against the city and was sustained by the Supreme Court in February, 1903.

In 1905 the Indiana legislature passed a law permitting cities of over 100,000 population to require railways to eliminate grade crossings. This apportioned 75% of the cost to the railway, 17% to the city and 8% to the county. Where street-car lines were involved the city was to pay 14%, the county 6% and the company 5%. In this case the company's share is figured on the cost of elevating 200 ft. each side of the center line of the street. The law provided that the cost to the city should not exceed $400,000 in any year, but this limit was removed by the repeal of the provision in 1911. All the track elevation at Indianapolis has been done under this law.

In 1905 the city passed an ordinance for the elevation of all tracks west from the union station property at Capitol Ave. to West St., about 2000 ft. This work was completed in 1909, the tracks coming down on a 1% grade to connect with the surface tracks at Capitol Ave. The railways at the east side do not come so near the station, and are elevated only at their connections with the Union R.R., beyond which they run down to grade. An exception is the Louisville division of the Pennsylvania Lines, which is elevated for about a mile south from the union station. In 1907 an ordinance was passed for the elevation of all tracks in the central district east of Senate Ave. This was supplemented in 1912 by an ordinance covering the territory from Senate Ave. east to Delaware St. and including the union station, while a later ordinance of 1912 extended this along the Indianapolis Union Railroad to the main-line junctions at Washington Street and Noble Street.

Main Lines and Freight Terminals

The largest proportion of the work and cost is for the Indianapolis Union R.R., which connects the several railways entering the city, as described in the preceding part of this article. Track elevation on these railways, beyond their junctions with the Union R.R., presents few significant features. Each line does its own work and employs its own designs and construction methods. To secure better street crossings, the Cleveland, Cincinnati, Chicago & St. Louis R.R. will in 1919 abandon its east-end junction at Delaware St. and will connect with the elevated tracks of the Pennsylvania Lines at Noble St., as shown on the map. In general, all this work consists of solid fills, with concrete retaining walls in the populated sections and with concrete abutments for steel and concrete bridges.

An exception to this class of work is that of the Illinois Central R.R. which has a single-track viaduct 2075 ft. long, with 75-ft. plate-girder spans. The station connection is made by a 430-ft. viaduct on a 16° curve, with girders supported on concrete four-post bents and carrying a concrete slab deck for ballasted track. This was completed in 1917. Its entire cost was paid by the railroad under an agreement made in 1915, when the line entered Indianapolis. Another 16° junction curve occurs at the middle of the station, but this is on the freight tracks, as it is for an industry line known as the Central R.R. of Indianapolis. A single-track viaduct 1000 ft. long, having a grade of 2.6%, forms the connection with the elevated station tracks. It occupies the center of Capitol Ave. and has plate girders on steel bents except for a short fill betwen retaining walls at the lower end. This was built in 1917-18.

Freight terminals of the trunk lines extend along both sides of the Union R.R., as shown by the map. Most of these remain at street level, inclined approach tracks being preferred to inclined driveways, but in several cases they have been altered to fit the new conditions. The Pennsylvania team yard between Pennsylvania and Virginia Aves. is elevated and will be completed in 1919, while a surface team yard at Noble St. will be completed in 1920. The C., C., C. & St. L. R.R. will elevate its terminals along South St. The Lake Erie & Western R.R. will build a freight house at the street level and its elevated team tracks will come to that level at Alabama Street.

Cost of the Work

The total cost of the track elevation will be about $18,000,000, the largest item being the work on the 1¼-mile line of the Indianapolis Union R.R., including the reconstruction of the union station. This will amount to about $9,000,000. For the elevation and reconstruction of freight terminals along this line, of which the city pays no part, the cost will be about $6,000,000. On the several trunk railways up to the end of 1918 there had been elevated 3¼ miles of main line, with 6¼ miles of track, exclusive of yard tracks, at a cost of $1,750,000. The remaining work includes 1½ miles of line with 3¼ miles of main track at an estimated cost of $1,300,000. Thus, about six miles of line are covered by the improvement.

Plans and reconstruction for all the grade-crossing work are subject to the approval of the city, represented for several years by B. L. T. Jeup, as city engineer. He was succeeded in 1918 by the present city engineer, F. C. Lingenfelter, who was formerly engineer of track elevation for the city.

Sewer Interconnections Made Compulsory in Wisconsin

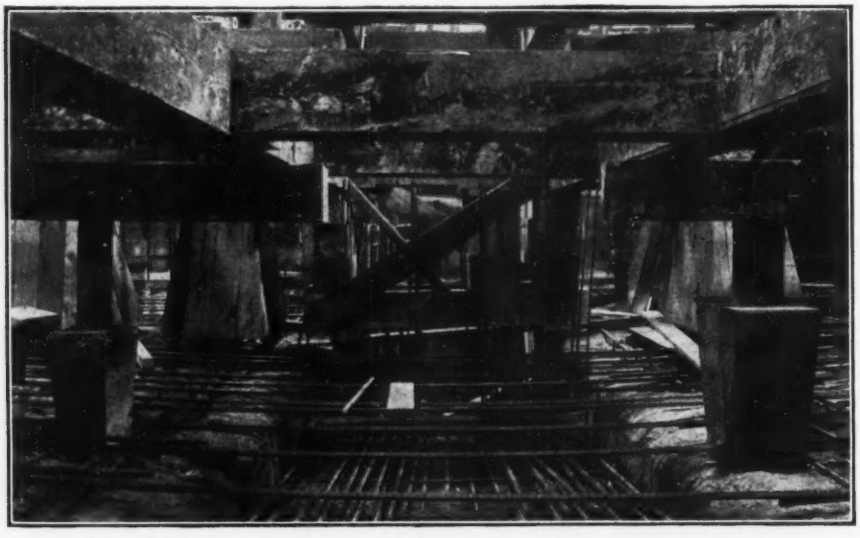
Under a Wisconsin statute which recently became a law the State Board of Health may require any sewerage system or sewage or refuse disposal plant to be so planned and constructed that it may be connected with any other similar system or plant, in order that the water-supply and health of any community in the same general drainage district may be protected. The sewerage commission or other body in control of the system rendering service is to determine annually the compensation, and the municipality receiving service must raise this amount by tax. Objections to the charge may be submitted to the arbritration of three referee engineers, whose majority vote will give the decision or action may be entered in the county court.

Cofferdam Experience at a Bridge in Chicago River

Flooding Due to Inaccurate Record of Old Tunnel—Movement of Wall in Deep Water Leads To Heavier Construction

By Hugh E. Young and William A. Mulcahy
Engineer of Bridge Design City of Chicago
Engineer of Construction City of Chicago

SEVERAL unusual experiences marked the construction of the combined piers and tailpits for the Michigan Ave. bascule bridge, described in *Engineering News-Record* of July 31, 1919, p. 210. Work on one pier was delayed 10 weeks by flooding of the cofferdam through an old tunnel. Bulging of cofferdam sheeting gave serious trouble, and heavy reinforcement was applied in order to hold the bulging wall until its bracing was in place. The piers, 52 x 66 ft. at the base, are large reinforced-concrete boxes supported on cylinder piers. The base of each box is 34½ ft. below water level. Flooding of the north cofferdam after its completion resulted from inflow of water through an old 6-ft. brick tunnel which passed under both cofferdams. This tunnel, carrying a 24-in. water main, was built about 50 years ago. No reliable plans or records were available, but the invert elevation was supposed to be 34.4 ft. below water level, and it was intended that the 45-ft. cofferdam sheeting would pass through it and form a seal. As the invert actually is at 66½ ft., the tunnel was not sealed. The shaft of the tunnel came within the south cofferdam, and its upper portion was found to be in excellent condition, built of two rows of brick in cement mortar. It was assumed that the tunnel brickwork was equally good and would sustain the interior pressure due to connecting it with the river. The shaft was therefore knocked away while the cofferdam site was dredged to a depth of 20 ft. to permit of placing the interior bracing. This permitted water from the river to enter the shaft and fill the tunnel.

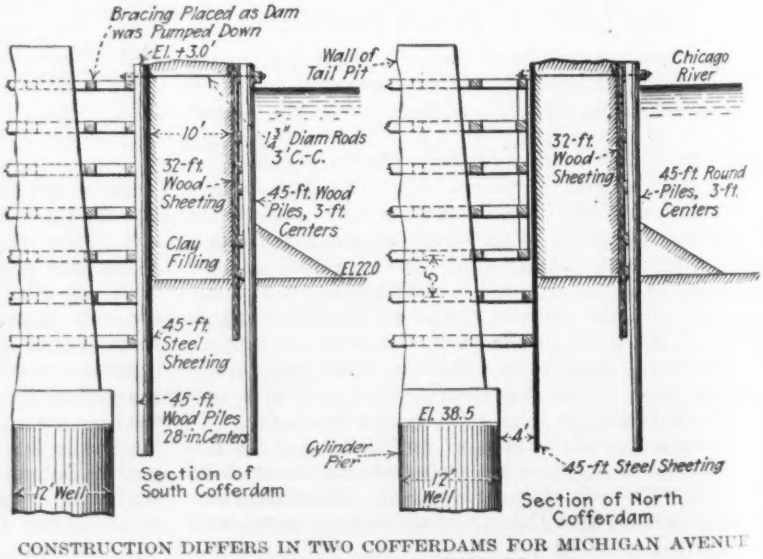


PILES AND CAPS SUPPORT BRACING IN COFFERDAM—BOXING KEEPS CONCRETE CLEAR OF PILES

Before this cofferdam was completed and pumped out, the sinking of the open wells for the cylinder piers was started in the north cofferdam, and had reached a depth of 60 ft. when a leak developed in a well which was within 3 ft. of the old tunnel. Bailing was tried, but in a short time the men had to be hoisted out of the well to save them from drowning and the cofferdam was gradually flooded to the river level. It appeared that the water in the tunnel, under 60-ft. head, had forced its way through the mortar joints and the surrounding clay. This mishap caused a delay of 10 weeks at the north pier, as work could not be resumed until after the south cofferdam had been completed and pumped out.

As wells for two 12-ft. cylinder piers in the south cofferdam had to pass through the old tunnel and extend to a considerably greater depth, a 5-ft. brick bulkhead was built within it to prevent any possibility of flooding these foundation wells. The 24-in cast-iron water main in the tunnel was in service up to the time of starting the bridge work, when it was shut off by a valve at the north end and the pipe drained by a tap at the south end. Two lengths of pipe were removed to clear the subpiers. This pipe line will be renewed when the new shaft and bypass connection to the tunnel are completed.

Interference of another tunnel further complicated the pier work. A concrete tunnel of the Chicago Tunnel Co. passed through the rear of the south cofferdam,



CONSTRUCTION DIFFERS IN TWO COFFERDAMS FOR MICHIGAN AVENUE BASCULE BRIDGE, CHICAGO

with its invert 26 ft. below water level. It was necessary to isolate a length of this by bulkheads outside the line of the cofferdam, so as to avoid flooding the extensive system of tunnels for handling freight and other materials in the business district. Traffic was diverted temporarily, and a tunnel diversion will be constructed after the pier is completed.

Very large cofferdams, about 75 x 105 ft. inside, were required for the construction of the piers. They differ somewhat in their wall and bracing details, as shown by the accompanying drawing, this being due to the fact that one was wholly in deep water and the other partly in shallow water.

For the north cofferdam, which was the first one built, there was an inner row of 45-ft. steel sheeting and an outer row of 32-ft. wood sheeting, the latter driven behind a row of 45-ft. round piles. This cofferdam was in water 16 to 22 ft. deep. Five sets of interior bracing were completely framed and submerged before the cofferdam was pumped out, the heaviest set resting on the bed of the river. This bracing was held down by skips loaded with loose rock.

A clearance of 6 to 9 in. was provided between the bracing and the sheeting, in order to permit of sinking the former to place. With this bracing completed, the puddle walls were built up with clay, as noted above. By the time the filling had reached the top of the cofferdam, 4 ft. above water level, the clearance had been eliminated and the steel sheeting was bearing firmly against the bracing. In other words, it had bulged inwards, due to the weight of the mass of clay in the puddle wall.

In the south cofferdam a different method of bracing had to be adopted, since only one-third of its area was in the river and it was impossible therefore to frame and submerge all the bracing in advance. One set of bracing was placed, but when the water was being lowered 5 ft. to allow of placing the second set the pressure of the clay fill caused the inner line of steel sheeting to bulge inward. A second row of 45-ft. round piles was placed on the inside to keep the sheeting vertical or prevent bulging. It was necessary to drive a row of 12 x 12-in. wood sheeting 50 ft. long in the front puddle wall, just outside the steel sheeting, in order to retain the clay and prevent further bulging.

A central row of piles at the bottom of each cofferdam supported the bracing and formed what is called the "backbone." This is general practice on large cofferdams, serving to keep the bracing from sagging as the water is pumped out. At all intersections of the bracing were placed the usual vertical shores or separators of 12 x 12-in. timbers. In addition, ¾-in. vertical tie-rods connected each two sets, being staggered on opposite sides of the separators.

At the bottom of the cofferdam, the piles were inclosed by boxing to keep them clear of the concrete. After the tailpits are finished and the piles are withdrawn, this boxing will be removed. This will leave square tapering holes in the 5-ft. concrete slab, which will be filled with rich concrete so as to make the floor water-tight.

The Great Lakes Dredge & Dock Co. has the contract for the substructure. The bridge is being built under the direction of the Board of Local Improvements, of which C. D. Hill is chief engineer. It was designed in the bureau of engineering, Department of Public Works. Hugh E. Young is engineer of bridge design, Thomas G. Pilhfeldt is engineer of bridges and John Ericson is city engineer. William A. Mulcahy is chief engineer in charge of construction.

Hollow Concrete Posts Packed With Sand

Belgian Engineers Devise a New System Which Permits Settlement—To Be Used Mainly in Mine Timbering

CONCRETE mine timbers which will permit some settlement if the support is overburdened have been designed by M. Muzak, a Belgian Government engineer. The device is described in *Le Génie Civil* of June 21, 1919, but it is not stated there whether it has actually been used or not. Information from other sources, however, indicates that some posts have been built and put into service.

The essential element in this new scheme is the use of a hollow reinforced-concrete column, which is filled with sand or other slightly compressible material through which the load is transmitted. A typical installation is shown in the accompanying cut. In Fig. 1 there is a mine frame in three parts. The arch for the roof is of precast concrete and is provided with a tenon which fits into the opening of the hollow post, which at its bottom fits also into the tenon on the base block. The post is spirally reinforced, and has to resist at the beginning of loading the radial compression of the sand which fills the hollow and which is compressed under load on the frame. If the roof settles, the sand will compress a certain amount, and if this amount is beyond the length of the tenon the post commences to take compression.

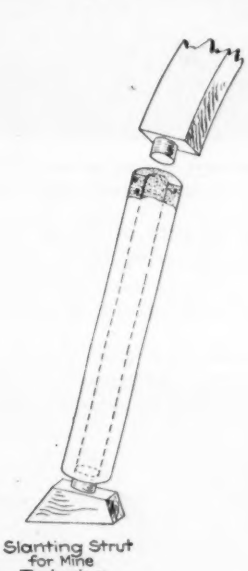


Fig. 1

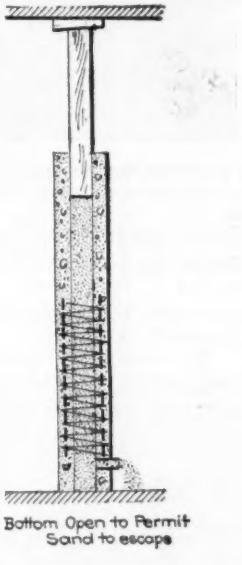


Fig. 2

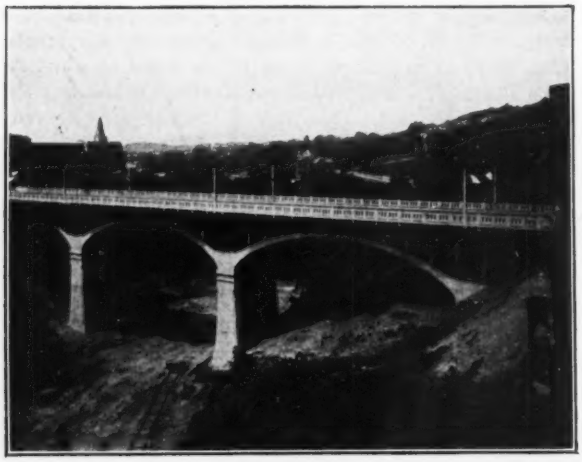
SAND-PACKED HOLLOW CONCRETE COLUMN AS USED IN MINE TIMBERING

Fig. 2 illustrates another type of the support in which the roof is supported by a direct wooden post penetrating into the top of the opening in the hollow concrete column. If the roof settles, in this type the movement is taken care of by the ejection of the sand through an opening at the bottom.

Flat Arches on High Piers, South Side Bridge, Fairmont

More Economical of Two Alternate Designs Is Adopted—Special Falsework Used for Salvage—Costs Affected by War Conditions

TWO complete alternate designs were made for the South Side bridge over Coal Run in Fairmont, W. Va., one consisting of a single 160-ft. main arch span, with one 60-ft. semicircular arch on the south end and two similar arches on the north side, and the other of three equal 116-ft. flat-arch spans on high piers. The latter design was adopted because of its symmetrical proportions and relative simplicity of design, which resulted in lower cost, the estimated approximate contractors' figures showing a difference of $28,700 in favor of this design.

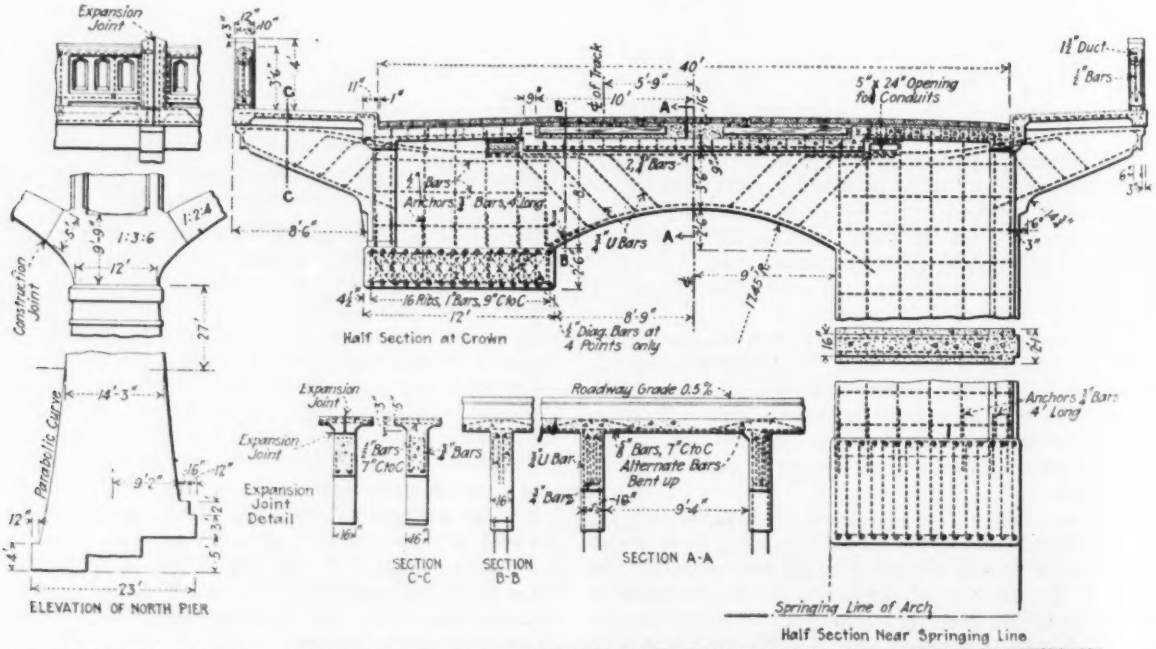


COMPLETED SOUTH SIDE BRIDGE—FLAT ARCHES ON HIGH CONCRETE PIERS OF EFFECTIVE OUTLINES

The new arch bridge replaced a steel viaduct highway bridge practically on the same center line. In order to maintain traffic as long as possible, the steel structure was continued in use, until it was absolutely necessary to remove it, requiring special and extraordinary solutions of the construction problem. Thus, the new piers were cast around the steel columns and bracing of the existing towers. The various structural steel members so incased were cut off 6 in. back of the face of the piers, and the square recesses left for this purpose were filled with mortar and neatly finished to the surrounding surfaces.

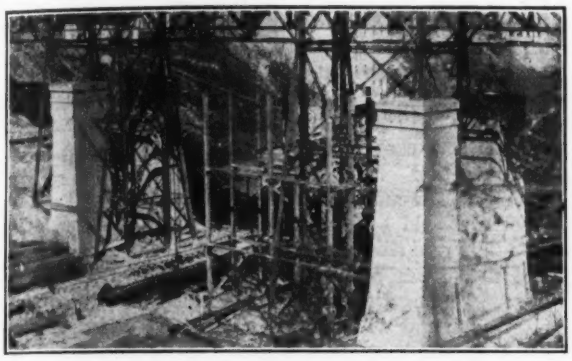
The contract was let on a cost-plus-fixed-sum basis, as lump-sum bidding entailed so much risk to the bidders as to make their bids excessive. In view of the unusually difficult labor and material conditions due to the war, the work was completed at a cost and within a time limit which agreed remarkably well with the estimated amounts. One element of economy lay in the special design of falsework for the arch centering, the long timbers of which were chosen because they could be utilized in the superstructure construction of walls and girders, as well as in the main pier cofferdams for the Monongahela River bridge now under construction by the same contractor.

General Dimensions—The new South Side bridge connects Adams Street with Fairmont Ave., Fairmont, W. Va., crossing a deep ravine about 535 ft. across and 100 ft. deep on a 0.5% grade. It consists of three equal 116-ft. arch spans on high piers. These spans are comparatively flat arches on piers about 62 and 55 ft. high, respectively. The concrete specified for the piers and abutments consisted of 1:3:6 mix, with large aggregate which would pass a 3-in. ring. The curtain and transverse walls up to the bottoms of the girders are of 1:3:6 mix, using large aggregate passing a 2-in. ring. The main arch ribs, the brackets, girders and floor slabs are of 1:2:4 concrete, with a coarse aggregate passing a 1½-in. ring.



CROSS-SECTIONS OF 116-FOOT ARCH SPANS OF SOUTH SIDE BRIDGE—PIER AND RAILING DIMENSIONS

The arch span adopted had a rise of 22 ft., the intrados consisting of a seven-centered curve, the ribs having a thickness of 2.5 ft. at the curve and 5 ft. at the springing line. As shown in the cross-section herewith, the bridge is 58 ft. wide, with two 12-ft. ribs carried by four solid independent piers and four abutments. The length of the structure between the faces of the abutments is 372 ft. The spacing of the transverse walls is uniformly 10 ft. 8 in. The structure carries a wood-block pavement, 40 ft. wide curb to



MASSIVE CONCRETE PIERS INCLOSE STEEL OF OLD TOWERS, FAIRMONT BRIDGE

curb, two 8-ft. sidewalks, and two trolley tracks 11½ ft. center to center.

The arch ribs were designed for a moving live load consisting of 50-ton electric cars, 150 lb. per square foot on the roadway outside of the car tracks, and 80 lb. per square foot on the sidewalk. The analysis was made by the use of influence lines, based upon the usual elastic theory. The total maximum dead- and live-load stresses at the crown are within 500 lb. per square inch in the concrete, based upon the assumption of fixed-ended arch ribs.

In order to estimate the effect of the deflection of high piers, an analysis was made, assuming fixed outer ends for the outside arch ribs and fixed bases at the piers. This analysis was based upon the movement of piers assumed as vertical fixed-ended beams, in connection with the working equations obtained to indicate the effect of movement of end abutments in the elastic arch analysis. The total maximum combined stress thus obtained occurred at the crown of the center arch under full live load in that arch, and amounted to about 600 lb. per square inch in the concrete.

Foundations—The geological conditions at Coal Run are typical of this coal-mining country; that is, there are alternate layers of sedimentary deposits. At the bridge site was a bed of relatively hard shale about 48 ft. thick overlying a bed of solid sandstone. On top of the shale was a similar solid bed of sandstone about 35 ft. thick. The south pier was founded on solid sandstone, while the north pier rests upon the overlying shale at an elevation about 6 ft. higher. The abutments for the end spans were carried into the upper layer of solid sandstone which outcrops on each side of the ravine.

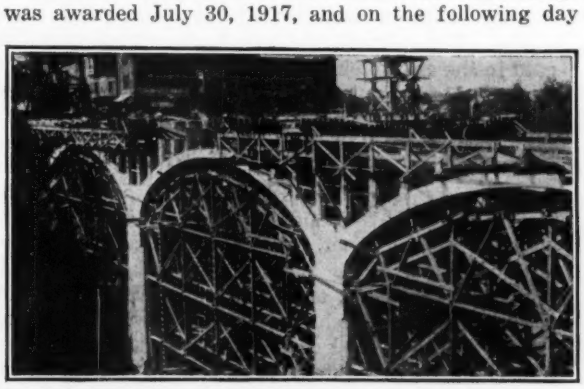
Both piers are 12 ft. square at the springing lines of the arches, and because of the flatness of the arch and the great height of these piers it was necessary to spread the pier footings to keep the foundation pressures within safe limits. To aid in developing this desired width and improve the appearance of the piers, the faces were battered to a point 27 ft. below the springing line, and then given the form of a parabola.

In order to economize in the cost of these massive piers, cyclopean masonry consisting of large stones bedded approximately horizontally with vertical joints filled around with the concrete, was used. Not more than 25% of the entire mass was occupied by these stones, cyclopean concrete being permitted up to the level of the springing lines of the arches.

The north pier was just inside one of the steel tower bents of the old bridge. It was concreted up to the springing line around the struts and diagonal braces of the latter, which were afterwards cut off 6 in. back of the face with an oxyacetylene flame, and the holes in the concrete were filled and finished. At the south pier, one of the column bents was concreted into the pier, and all projecting members were cut off at the time of the removal of the steel superstructure. The contractor was thus able to complete the piers and erect the arch centering before beginning to dismantle the old bridge. As this old bridge carried the main-line traffic of the Monongahela Valley Traction Co. between Clarksburg and Fairmont, and as its removal required a detour of four or five miles, it was essential to postpone the interruption to traffic as long as possible. A foot-bridge 5 ft. wide was maintained for pedestrian traffic.

The old structure, which consisted of five wrought-iron spans on towers, with steel trusses and towers erected later to carry the electric railway, was removed by burning around the main joints with the oxyacetylene torch, beginning at the south end. The cableway was used in removing the members, and the dismantling operation was facilitated by cantilevering the trusses over the supporting towers.

Construction Methods—The contract for this bridge was awarded July 30, 1917, and on the following day



ERECTION FALSEWORK—VARIOUS STAGES OF CONCRETING

the first material for the new bridge was ordered by closing an option on the steel required for the structure. The next four weeks were used in assembling and shipping the contractor's plant; and for the four months beginning in September the excavation and foundations for piers proceeded. Pier shafts were carried up to the arch springing line, and the arch centering plans were developed.

One cableway, just clearing the outside easterly line of the bridge and the old steel structure, was used in the pier work. An additional cableway was erected on the center line of the new structure for the balance

of the construction work, which was actively begun on the main arch in April, 1918.

The old bridge was left in place to accommodate traffic until June 3, during which months practically all materials were assembled and stored on the job, to avoid risk of delay due to lack of materials. From this time up to Thanksgiving Day, Nov. 28, 1918, when the structure was formally opened to public travel, the progress was fairly continuous, considering the difficult labor conditions.

The mixing plant was located about at the center

MOVABLE HOPPER FRAME—TWO CABLEWAYS USED

of the middle span near a railroad siding, to reduce to a minimum the handling of materials. The two cableways were of 540-ft. span, with 10-ton capacity, and were used to deposit buckets of concrete in the hoppers placed on a movable frame near the center line of the bridge.

Erection Falsework—The erection falsework for the arch ribs was specially designed by the contractor to make possible the greatest amount of salvage of timber for use in the construction of the Monongahela River bridge. For example, the long timber posts were later used in the cofferdams of this bridge. They are 40 x 80 ft. in size, and the transverse timbers, 60 ft. long, used to tie the arch centering together, was later utilized for the transverse wall forms. (See cut, opposite column.)

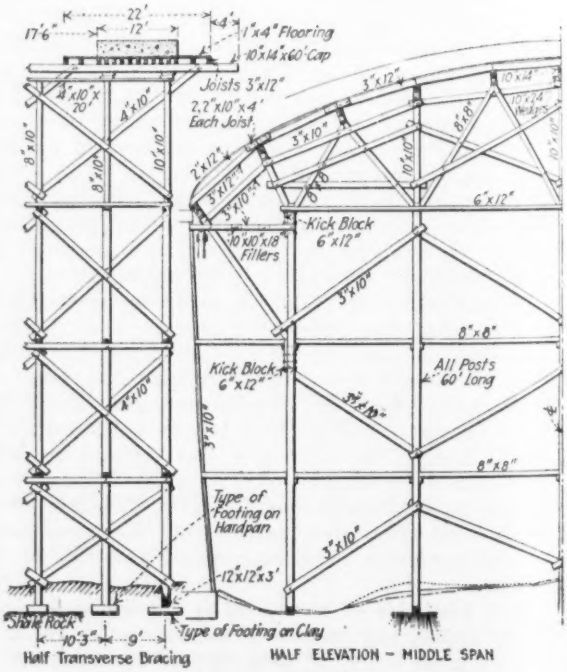
The railing forms were designed of cypress to eliminate warping, and were used over and over, the complete railing on both sides being placed within three weeks. The last floor panel was cast at the opening left in the center for the cableway hoist on Nov. 14, and two weeks later, on Thanksgiving Day, the traffic passed over. The arch centers were lowered about one month after the final concrete was poured, the operation being carried out by beginning at the crown and working each way with wedges, as indicated by the drawing.

The plant employed by the contractor consisted of one motor-driven concrete mixer, with fixed batch hopper, fed by gravity from overhead bins of about 50-cu.yd. capacity. The bins were in turn kept filled with sand and gravel by a clamshell on a 78-ft.-boom guy derrick handling materials from stock piles. The derrick was operated by a three-drum engine equipped with a 60-hp. boiler, which furnished steam also for an air compressor. The latter supplied air for the operation of wood-boring machines used in the form erection. A saw mill with rip, cut-off and band saws was operated in connection with the form work. The concrete was handled from the mixer in 1-cu.yd. buckets on the cableways, which were also used in the demolition of the old bridge and the handling of forms, etc.

COMBINATION LIGHT AND TROLLEY POLE

The final total quantities of concrete were 3400 cu.yd. of 1:3:6 mix, 2400 cu.yd. of 1:2:4 mix, with 195,000 lb. of steel bars. The final cost to the City of Fairmont was a little over $174,000. The total cost of the bridge, however, was $192,300, including the contractor's compensation, fixed at $15,600. The old bridge steel was sold as scrap for about $20 per ton. Common labor varied from 30c. in 1917 to 50c. in 1918, and mechanics and carpenters from 60c. to 80c. per hour. During the summer a decided scarcity of labor developed, and willing high-school boys and young men filled up the gaps in the gangs quite efficiently.

Both alternate designs were made by the Concrete-Steel Engineering Co., William Mueser, chief engineer. E. H. Harden for a few months, and Charles F. Bornefeld for the major part of the work, were resident engineers for this company at Fairmont. The John F. Casey Co., of Pittsburgh, Penn., was the contractor, with Samuel L. Fuller as superintendent on the work, and E. J. Gass designing engineer. The structure was erected under the administration of the Board of Affairs of the City of Fairmont, W. Va.; Albert L. Lehman, commissioner of bridges and streets, and Shrewsbury B. Miller, city engineer.



DETAILS OF ERECTION FALSEWORK FOR ARCH CENTERING

Some Problems in the Design of Concrete Ships

Special Details of the Structural Design as Developed by the Experience on the Government Concrete Ships

By J. Glaettli, Jr.
Concrete Ship Section, Emergency Fleet Corporation, Philadelphia, Penn.

The following section of Mr. Glaettli's paper before the recent convention of the American Concrete Institute relates to the specialties of structural design in concrete ships. The remainder of the paper was devoted to questions of naval architecture, ships' fittings and stress determination, and are more general in their nature.—Editor.

While the solution of the problems involved in the design of the concrete members for the Government concrete ships has been no easy matter, the number of problems involved has been comparatively small, and experience alone will demonstrate whether they have been correctly solved. Successive designs have in general shown a decided improvement over those that have gone before, and unquestionably the latest designs are far better than the earlier ones. The individual problems that arose are discussed in detail in the following paragraphs.

Continuous Beams and Compression Reinforcement—In order to reduce the weight of beams, frames and slabs to a minimum, all members whose cross-section was largely determined by the intensity of the moment to be resisted were designed as continuous beams wherever the construction was such as to enable this condition to be realized. In many instances, compressive reinforcement was added in order to reduce the gross cross-section of members but in the usual case reinforcement was used on both faces to provide reinforcement for negative moment over the supports.

Percentage of Steel—At the very beginning of the work of design, it became evident that larger percentages of steel would be required in the design of concrete members than had hitherto been used in common practice. It also became evident that the resistance to shear or diagonal tension would have to be increased by using more steel or by using it in a different arrangement. Higher unit stresses in the concrete have also been found desirable to a limited extent. The use of the working stresses adopted has been fully justified by the experimental work done.

The amount of steel used in the various designs ranges from 3 to 4 per cent. of tensile steel and from 1 to 4 per cent. of compressive steel. If web reinforcement be included, the total amount of reinforcing steel in concrete ships thus far designed by the Concrete Ship Section ranges from 5 to 9 per cent. by volume or from 22 to 40 per cent. by weight, assuming concrete weighing 110 pounds per cubic foot.

Unit Stresses in Flexure—There seems to be a well-established opinion among those not familiar with concrete ship design that the unit stresses in a concrete ship are materially greater than are those in land structures. This, however, is not the case and it can be said that with few exceptions the stresses are as conservative, if not more so, than the stresses used in land structures. In a great many cases members are subjected to reversing moments, a condition which requires steel on both faces of the member. If these moments are equal in magnitude, the amounts of steel on each face must be nearly equal, and the compressive strength of the concrete is then of no exceptional advantage, the tensile steel on one face being sufficient to carry the compressive stresses when the moment is reversed. However, to keep the structure intact, a safe working stress of from 1000 to 1500 lb. per square inch must be permitted in the concrete. In view of the fact that in certain parts of a ship the steel stresses must be kept low to prevent leakage, we find numerous instances where the stresses are more conservative than usually supposed. In very few instances have the unit stresses in the steel for ordinary service conditions been increased above 16,000 lb. per square inch.

Unit Stresses in Shear—The usual method of designing shear members on land structures has been to assume that a large proportion, say 75%, of the shear, is carried by steel stirrups at a unit stress of about 75% of the usual tensile working stress in the steel. In the design of concrete ship members, except the shell, it has been the practice to assume that all of the shear is carried by steel stirrups at 16,000 lb. per sq.in.; this method giving the same results as obtained in common practice. It has been assumed that the webs of beams could be reinforced to the extent of permitting a maximum working shearing unit stress of 500 lb. per sq.in., and then assuming that all of the shear or diagonal tension is carried by stirrups. For this item alone can it be said that radical departures have been made from common practice. The results of tests justify the use of such large percentages of web steel.

Reinforcing the Shell for Shear—The side shell of a ship is subjected to shearing stresses of a reversing character, and the best arrangement of steel to resist such shearing stresses is not easily determined. It is generally conceded that diagonal rods are more effective than vertical rods for resisting diagonal tension, especially before the concrete has cracked. If the shears are reversible two sets of diagonals must be provided at right angles to each other, while only a single set of vertical rods is needed.

Using the same unit tensile stresses in the vertical as in the diagonal bars as was done in the first ship designed by the Concrete Ship Section, the amount of vertical steel required is only half as great as the amount of diagonal steel needed. However, with the use of vertical rods to resist shear, it becomes necessary to add horizontal rods to tie the structure together, and the apparent advantage of the vertical steel is somewhat reduced. In addition, the disadvantage of having horizontal rods in thin vertical slabs at the time of pouring must be considered.

It can be demonstrated analytically that vertical shear reinforcement takes little or no stress as long as the concrete remains intact, and laboratory experiments bear this out. It is to be expected, then, that diagonal reinforcement is the more effective in preventing cracks from forming and in keeping the width of the cracks down once they do form. The work of the investigation branch of the Concrete Ship Section indicates that lower working stresses should be used in vertical rods rather than in diagonal rods in order to keep the size of cracks down to a minimum.

When using a materially reduced working stress for vertical bars, in the design of the side shell of a ship, it is found that the amount of vertical steel required

is about 90 per cent. of the amount of the total steel in both sets of diagonals. The use of horizontal rods in conjunction with the vertical rods eliminates even this saving of 10 per cent., and less steel is required if placed in a diagonal direction.

It does not follow, necessarily, the diagonal steel reinforcement should be used in preference to vertical. The problem is invariably complicated by the conditions of local bending that must be provided for. Diagonal steel is generally not as effective for carrying local bending as are rods which span the panel in the direction of the shortest dimension. It is probable that a combination of vertical and diagonal steel is as efficient and economical as can be expected. What proportion of shell steel should be placed vertically and what amount diagonally depends on the thickness of the slab, the direction in which local bending is carried, the sizes of rods to be used in the shell, the maximum and minimum spacing of rods, and other features.

Kind and Size of Rods—Nearly one-half of the steel in a concrete vessel is in the deck and bottom, where the bond stress is exceedingly low, and where deformed bars have no advantage over plain rods. This feature and the difficulties which have arisen in the field with deformed rods have led the Concrete Ship Section to specify plain round rods for all vessels.

While large-diameter rods have been used in certain designs with a view to reducing the number of pieces to be handled, the difficulties encountered in bending the steel have demonstrated that the rods should be as small as can be conveniently placed in beams and slabs. In slab design particularly should small rods be used. The use of small steel rods (less than ¾ in. diameter) in the shell is especially encouraged because their use eliminates all previous bending of the steel for the turn of the bilge. The size of rod best suited for a particular location depends on the thickness of the member, the number of bends, etc., as well as on the requirements of design.

Thickness of Cover Over Rods—A simple calculation will show that if the upper deck and shell of a 7500-ton ship can be reduced in thickness ½ in., there will result a net saving of roughly 30 tons in the hull weight and a corresponding increase in dead-weight carrying capacity. It is therefore of prime importance that the cover of slab steel be reduced to the minimum required for the protection of the steel. Foreign practice seems to consider 1 cm. sufficient, a figure which compares favorably with the ¾-in. cover used by the Concrete Ship Section. The above figures can be applied to illustrate how important it is to build forms exactly to size and to hold them rigidly in place. The inner and outer bottoms, decks and other slabs built without forms should also provide no more than the cover called for on the plans.

Screeding Easements of Banked Highway Curves

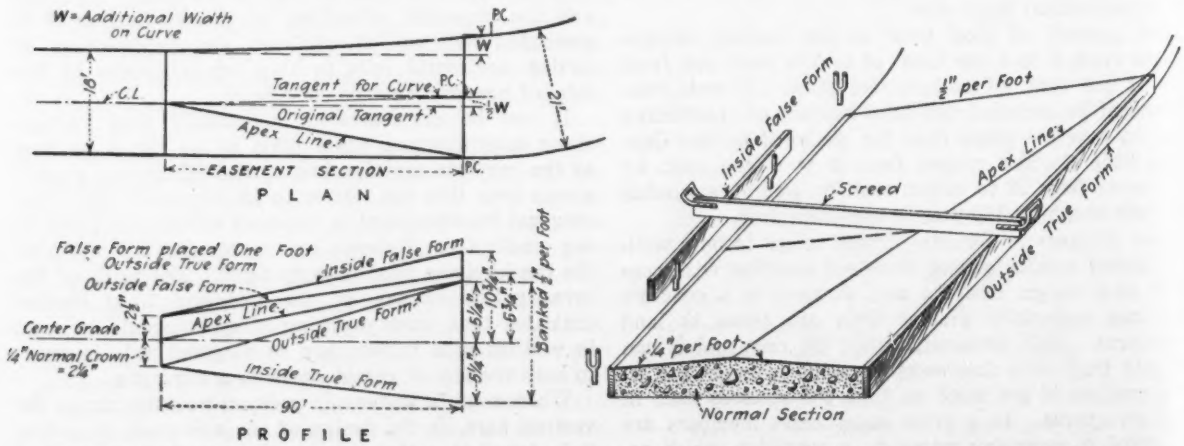
Method of Setting True and False Forms for Templet to Ride—Transition Cannot Be Seen After Construction

By George A. Curtis
District Engineer, Massachusetts Highway Commission, Springfield

SCREEDING the transitions from the normal or crowned sections to the banked sections of concrete-road curves is difficult, on account of the warped surfaces which result from changing from double to single slope sections. It may be accomplished, however, by setting auxiliary sets of false forms to be used with the true forms and drawing the templet twice. While this produces a diagonal ridge or apex along the transition or easement, it cannot be seen after the construction is completed. With other types than concrete pavement, the apex line must be staked out.

The length of the easement naturally depends on the amount of change in pitch from the normal to the banked section. This varies from about ½ to 1¼ in., according to the radius of the curve. The maximum change is on the outside of the curve, where the pitch from the center of the road must change from a minus at the beginning of the easement to a plus at full banked section. Thus, in changing from a ¼-in. crowned section to a ¼-in. banked section, this pitch has been changed ½ in. Thirty feet of easement should be allowed for each ¼-in. change in pitch. The full bank should extend from the P. C. to the P. T. of the curve, the easement section extending back on the tangent for a length as determined above.

As it is customary to widen the road at curves from 3 to 6 ft., the center line should be moved parallel to the original and a distance toward the center of the curve equal to ½ the additional width. This is done in order to give a good alignment to the outside of the



LAYOUT AND METHOD OF SCREEDING EASEMENT—ALIGNMENT AND GRADES OF TRUE AND FALSE FORMS

easement and curve, as well as to throw all the widening toward the center. The apex of the cross-sections is continued practically in a straight line from the center of the roadway at the beginning of the easement to the extreme outer edge at the P. C. This apex line divides the easement into two sections, designated as the inside or outside of the easement, according to whether the section is toward the inside or the outside of the curve. The normal pitch is maintained on the outside of the easement until the latter runs out at the P. C. This gives to each cross-section a pitch at least as great as that on the normal section, thus allowing for proper drainage.

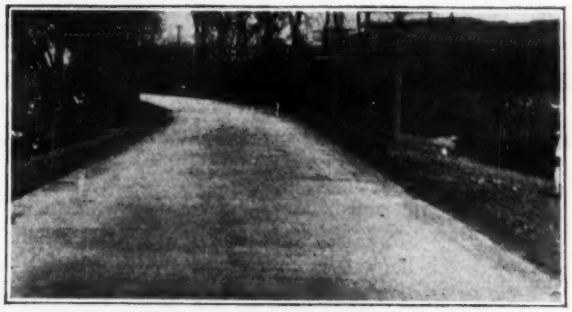
The easement section for concrete-road curves is mechanically obtained by means of a set of auxiliary forms called "false forms," placed 1 ft. outside the true concrete forms. A straight screed is used, as also on the full banked section. In screeding, one end is rested on the true form at one side, and the other end on the false forms at the opposite side, and vice versa. All grades given for the true as well as for the false forms should be referred to the corresponding profile grade. The grades for each set of forms and for the apex line vary uniformly from the beginning of the easement to the P. C. To illustrate, assume a normal crowned section 18 ft. wide with a ¼-in. pitch, and a full banked section 21 ft. wide with a ½-in. pitch. The ¼-in. pitch of the normal section is continued on the outside of the easement, until the latter runs out at the P. C. The inside of the easement increases uniformly from a ¼-in. pitch at the beginning to a ½-in. pitch at the point of curve.

Determining Grades of True and False Forms

Grade for the inside true and false forms, the outside true and false forms and the apex line—all referred to the center grade—are shown in the profile. From this, the relative heights of the true and false forms for any point on the easement may be scaled directly. The isometric view (scale greatly exaggerated) illustrates the method of screeding. The inside false form has been omitted for clearness. For the false forms, Y-brackets, 10 ft. apart, are driven to such depth that the upper edge of a 2 x 6-in. board, 12 ft. long, resting in them, will be at the required grade. This piece may be moved along as required or taken out of the way when screeding on the other set of forms. A view of completed easement is shown, the transition starting at the expansion joint in the foreground.

Easements for other than concrete surfaces are obtained by first staking out the side lines, using the grades shown for inside and outside true forms, and then staking out the apex line to grade. In cases where the pitch of the bank is the same as that of the normal section, the apex line will be straight. When the banked section has a greater pitch than that of the crowned section, it will be found that the apex line bows outward somewhat. In the case above mentioned, the bow amounts to only about 0.7 ft. For practical purposes, therefore, it may be assumed to be straight. It is recommended that construction stakes on this line be sawed off to grade and that corresponding reference stakes be placed just outside the work.

Reverse curves should be avoided if possible, and an attempt made to obtain sufficient tangent length between to allow for the transition. The transition from



COMPLETED EASEMENT DOES NOT SHOW TRANSITION FROM NORMAL TO BANKED SECTION

full bank to reverse full bank is done by pivoting the straight-line cross-section about the center grade. Assuming each full bank is of ½-in. pitch, the total change in pitch would be 1 in. and, according to the rule, would require 120 ft. of tangent. While the above represents the ideal, the transition may be made in a shorter tangent length, by extending some of the transition back on the curves. When dealing with actual reverse curves, care should be taken not to make the transition too abrupt, and to keep in mind the rule requiring 30 ft. in which to make a ¼-in. change in pitch.

It sometimes happens that nearby curves both in the same direction are separated by a short tangent. When this tangent does not exceed 1½ times the figured easement length (1½ E), the full bank and full width should be maintained throughout. When the tangent length exceeds this, the regular easement sections should be started from the adjacent points of curvature and continued toward each other until within a distance of 1½ E. The cross-section then arrived at should be maintained for this intervening distance. It will thus be seen that in order to return to normal section between nearby curves in the same direction, the tangent between would have to be at least 3½ times the figured easement length.

High Prices for Engineering Materials in France

Representative retail prices of building material, tools, hardware, etc., in France, which are the bases of settlement on which many of the claims filed with the Department of Rents, Requisitions and Claims are being settled, indicate a higher scale than exists in this country. Only for sand, gravel and crushed stone, with which France is well supplied almost everywhere; does the price approach levels in the United States. The prices have been converted into American units, with exchange assumed at 5.70 francs to the dollar.

REPRESENTATIVE PRICES FOR ENGINEERING MATERIALS IN FRANCE

Lumber and construction timber, pine and fir	per thousand	$120.00
Oak flooring	per thousand	250.00
Red brick, common	per thousand	38.00
Fire-brick	per thousand	79.00
Roofing tile	per thousand	67.00
Pitch	per 100 lb.	14.00
Cement tile, 6-in. diameter	per linear foot	.15
Nails and spikes	per pound	.27
Bridge augers	each	$1.00
Small stone hammers	each	.90
Window glass, double strength	per square foot	.57
House paint	per 100 lb.	45.00
Sand, at pit	per cubic yard	.55
Gravel, at pit	per cubic yard	.80
Crushed stone, at quarry	per cubic yard	1.20
Electric light wire	per linear foot	.023
Electric lamp cord	per linear foot	.054
Leather belting, 5½ in. wide	per linear foot,	1.30
Leather belting, 8 in. wide	per linear foot	1.95
Castings, milled, weight 10 lb. each	per pound	.16
Brass bushings	per pound	.87

Reconstruction of the Naches-Selah Irrigation Canal

Parts of Old Sidehill Canal in Disrepair Replaced, Under War Conditions, by Concrete-Lined Tunnels, Reinforced-Concrete Flumes, and Canal With Wire-Reinforced Concrete

By Elbert M. Chandler
Chief Engineer, Naches-Selah Irrigation District, Yakima, Wash.

DURING the most difficult year for construction work ever experienced in this country, the Naches-Selah Irrigation District carried out some interesting reconstruction work on its canal system. This involved tunnel, flume and canal work in concrete. The following notes describe the work, with particular reference to construction details, but the more notable features of design are also brought out. Tunnel cost figures are included.

The district comprises some 10,500 acres of highly developed orchard lands in the Yakima Valley, Washington. The water is diverted from the Naches River about a mile above the mouth of the Tieton River and some 20 miles upstream from the City of Yakima. The diversion dates from 1888. The original length of

TUNNEL FACE SHOWING USE OF COAL AUGERS

the main canal was 19 miles, terminating at a division point where three main laterals start to distribute the water. The entire length of the main canal is made up of steep sidehill construction, originally of the usual pioneer type—earth canal and wooden flumes.

In the summer of 1917 the canal reached such a state of disrepair that several serious breaks occurred, resulting in interruptions to the water service aggregating over 30 days and a loss in the apple crop estimated to be not less than $500,000. The writer was engaged at that time to make a study of the situation and prepare a plan for the permanent reconstruction of the entire system.

For the main canal, the general plan contemplated abandonment of the first seven miles whenever the proposed Government high-line canal, which would parallel and lie above the Selah canal, was constructed, provided that an arrangement could be made with the Government to share in the cost of construction and operation jointly of the new canal. From the point where the high-line canal would leave the Selah canal, a plan was worked out whereby the remaining 12 miles would be ultimately shortened 5.3 miles in length, and of the 6.7 miles to be reconstructed, less than three miles would follow the original location. The outstanding feature of this program of reconstruction was the use of 16 tunnels, aggregating 21,000 ft. in length, the tunnels to be connected by reinforced-concrete flumes and by canals lined with reinforced concrete.

It was decided in February, 1918, to issue $375,000 of bonds to carry out as much of this plan as was urgently necessary. Accordingly, since May 1, 1918, the district has constructed eight tunnels, totaling 8718 ft. in length, 3100 ft. of reinforced-concrete canal lining, and 1200 ft. of reinforced-concrete flume, all of which was completed and carrying a head of water at the opening of the irrigation season on Apr. 1, 1919. During the winter of 1917-18, before the bond issue was voted, one tunnel 600 ft. in length, and 2600 ft. of canal lining, that had to be ready before the 1918 irrigation season, were completed. The balance of the improvement will be carried out more slowly, as required.

All of the tunnels are 7 ft. wide in the clear, with flat bottoms, side walls from 4 to 5½ ft. high to the spring line of a segmental arch having a 2-ft. rise. All lining, except in timbered sections, is 6 in. thick, except that in rock a floor thickness of 4 in. was used.

A uniform net width of 7 ft. was adopted (1) so that standard forms for lining the roof could be used interchangeably between tunnels, and (2) because that was about the minimum width for working advantageously on the face and for mules, which were used in hauling out the muck, to turn around. The height of walls depended upon the grade available, which varied with the amount of old canal eliminated. All recaptured grade was placed in the tunnels. To obtain the necessary water-sectional area, the grade was dropped below the old grade line wherever required.

The tunnels were all driven by station men. In the early stages of the work five tunnels were being driven, double-ended and double-shifted at one time, with a maximum aggregate daily progress of 140 ft. In all cases but one, the drilling was done with coal augers, as the material encountered was either sand rock or shale, relatively soft and dry in all cases.

The tunnel lining was performed in an unusual manner. The floor was first laid like a sidewalk, with 2 x 6-in. ribbons on each side for forms set accurately to grade, and the concrete was filled in between, leaving a space at each side for the thickness of the walls.

Ordinary forms, in sections, were used for the side walls and carried forward and used again and again. They were braced both at the bottom and top to the opposite side to prevent bulging. After the forms for the side walls were removed, the concrete was placed in the roof by shoveling into the end of collapsible forms, male and female, 4 ft. long, hinged at the key of the arch, carried on both sides by wooden supports accurately adjusted to grade by wooden wedges, with the concrete rammed back into place by wooden poles. Four men in the tunnel, two taking turns shoveling overhead, and two, one on each side, tamping back into place, would ordinarily put in 60 ft. of roof in eight hours, the maximum record being 76 ft. in one day. A relatively dry mix was most satisfactory for the roof,

while a wet mix was best adapted to the floor and sides. A 1:2:4 mix was used for the floor and sides for water-tightness, while 1:3:5 mix was used for the roof.

The costs of driving and lining are given in the accompanying table. It must be noted that this work was carried out during the stress of war; that common labor was paid from $3.60 to $4.50, most of the time

freeboard, was selected to carry 135 sec.-ft., Kutter's n as 0.016, a high but safe assumption.

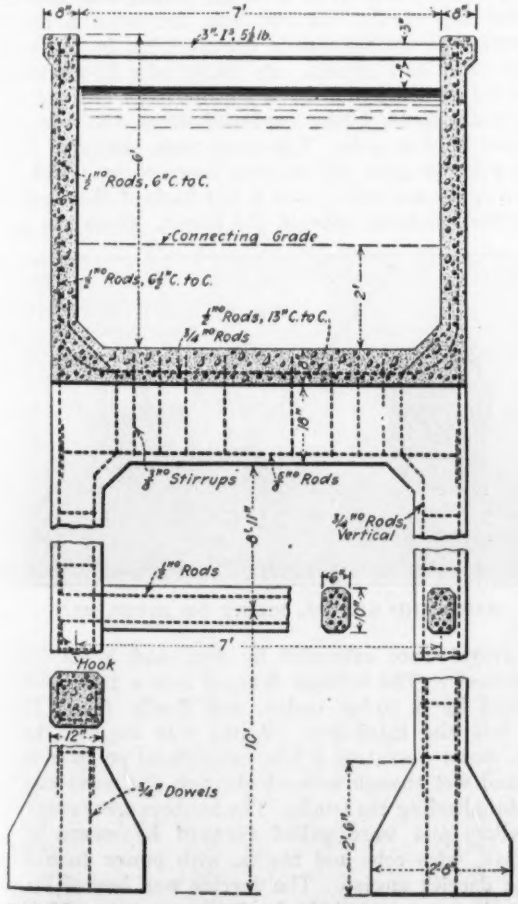
The flume box is designed to be supported entirely by the floor between bents spaced 10 ft. apart. The walls are tied together every 6 ft. by a 3-in. I-beam embedded in the concrete, the ends of which serve as points of reaction for a concrete-steel beam between I-beams, the beam in turn serving as a line of reaction

COST OF DRIVING AND LINING EIGHT TUNNELS FOR NACHES-SELAH IRRIGATION DISTRICT, YAKIMA VALLEY, WASHINGTON

Tunnel No.	Length, Ft.	Cost Total	Cost Per Lin.Ft.	Excavation Cost Total	Excavation Cost Per Cu.Yd.	Lining Cost Total	Lining Cost Lining per Cu.Yd.	Material Excavated
1	1920.0	$40,695	$21.20	$18,173	$4.10	$22,522	$22.20	Sandstone of varying hardness and irregular fracture.
2	782.5	18,949	24.20	9,353	5.20	9,596	22.80	Cemented gravel and large boulders. Could not use augers or machine drills. Much overbreak.
9	1363.0	27,357	20.00	10,437	3.33	16,920	23.40	Soft sandstone. Concrete run in from one end only.
10	1080.5	21,293	19.70	8,445	3.39	12,848	22.30	Soft sandstone.
11	883.0	16,294	18.20	6,973	3.89	9,321	21.00	Soft shale with considerable gravel intermixed.
12	893.0	16,047	18.00	6,285	3.51	9,762	22.00	Soft shale. Lined in winter. Water hauled several miles under bad conditions.
13	651.0	12,204	18.70	4,645	3.32	7,559	22.40	Soft shale. Concrete material hauled 5.7 miles.
14	1145.0	22,468	19.60	7,162	3.13	15,306	27.20	Soft shale with considerable overbreak. Concrete material hauled 6 miles and water 3 miles in winter over almost impassable roads.
Total,	8718.0	$175,307	$20.10	$71,473	$3.73	$103,834	$23.00	Estimated cost, made in 1917, was $4 for excavation and $20 for lining.

the latter; and that workmen were very scarce and mostly old men. The costs include everything except engineering, legal expense and contractor's compensation.

The reinforced-concrete flumes connecting the tunnels are 7 ft. wide and 6 ft. deep. The width was chosen to match the width of the tunnels and make the elimination of transitions possible. The depth, with 1-ft.



NORMAL SECTION OF IRRIGATION FLUME ON BENTS

for the upper side of the sidewalls, themselves acting as steel-concrete beams. The lower edge of the sidewalls is supported by steel ties into the floor. No contraction joints were used, but 0.4% of the concrete volume in temperature steel was added, extending well into the tunnels as anchors at each end. Round steel was used, in preference to deformed bars, to facilitate movement of concrete material, and a very wet mix was used, as there was little opportunity for spading. Concrete was poured continuously for each flume until finished. On one of these flumes, it was necessary to make a rock cut of 30 ft. to grade and follow it immediately by an overhead flume supported by a 60-ft. reinforced-concrete arch. The arch was necessary because of unsatisfactory foundation conditions.

For the connection between Tunnel No. 10 and the trapezoidal section of the canal lining, a design of reinforced-concrete flume was worked out upon different principles. Here there was no reason why the economic hydraulic cross-section should not be used (the width equal to half the water depth) and a width of 8½ ft., with a gross depth of 5 ft., was selected. As before, the floor is designed to carry the flume between bents spaced 10 ft. apart, but there are no ties across the flume, and the walls are designed as cantilever beams to withstand water pressure only. The location is such that the walls will not be required to withstand pressure from without, as might be the case with the steel-concrete flume heretofore described. As before, there are no contraction joints, but there has been added 0.4% temperature steel. The flume is 600 ft. long, was poured in cold weather (temperature about 35° F.) continuously. Where it joins the trapezoidal lining, by a warped surface transition, an anchor wall has been provided and the longitudinal steel extended into that. The steel at the other end extends for 10 ft. into the tunnel. Shortly after the flume was poured, zero weather was experienced for a prolonged spell of ten days, and during that time two or three contraction cracks were noticeable. When the temperature went back to 30° F., or above, the cracks were closed up and not visible to the naked eye. Since then the temperature has been up to 85° F., with water in the flume and no leaks from cracks.

In places where the reconstructed canal followed the original location, the old canal was lined with concrete. The shape of the old canal was very irregular, with much vertical timber side-lining on the outer bank, and the grade in many places was high. A section was chosen for the most common grade with a base width of 12 ft., side slopes of 1½ to 1 and a depth of 4 ft. In addition, a dip was given the floor, from each side, of 6 in. to the center, and a 4-in. tile drain was laid

REINFORCED-CONCRETE FLUME BETWEEN TUNNELS

under the center, with outlets about every 600 ft. A coping of 7 in. on each side was provided. No. 11 electric-welded 12 x 12-in. mesh wire was embedded in the concrete. Construction joints every 5 ft. were weakened by a screed so as to concentrate all contraction cracks in definite lines. Concreting was continued in the coldest weather possible without injury from freezing.

In most cases, the lining was through adobe soil or soil very retentive of moisture. Previous neighborhood experience with lining had been very unsatisfactory; this was due to frost action. Consequently, unusual precautions were taken. The lining was run in cold weather, so that any cracks due to temperature changes would be made tight by expansion during the irrigation season, and thus leakage to the subgrade would be prevented. In case any leakage should occur, the floor of the lining was dipped to the center, to facilitate rapid flow to the drain and give the floor more resistance to heaving from frost. The drain is surrounded by coarse gravel and will quickly take away any surplus water. The steel mesh was added to give additional strength to the concrete in tension and to prevent any cracks arising from uneven settlement of the subgrade, although all fills were carefully hand-tamped moist. The mesh will not be sufficient to prevent cracks due to temperature contraction in cold weather, but the canal is empty then, and the cracks will be concentrated at 5-ft. intervals so as not to be large or located irregularly between construction joints. The coping at the top is provided to prevent surface moisture getting under the lining sides and causing disintegration by heaving. All lining is 3 in. thick, of 1: 2 : 4 mix, and n was assumed at 0.016. The 1½ to 1 side slope was selected in preference to any steeper slope, because it is about as steep as a wet mix can be plastered on a slope of that width. The mesh was purchased in rolls of sufficient widths to require two on the bottom and one on each side. It was easily placed by rolling out down the canal and tied together crossways by small projections of wire provided on the side of the mesh.

The cheapest labor on the lining was $4.50 per day and quite inefficient. The finishers were paid $6 per day and were only handy laborers. The preparation of the subgrade was of such character as to be practically all handwork and very expensive. For the lining, completed, the cost was $8.45 per linear foot, exclusive of engineering and of contractor's compensation. Of this amount, the preparation of the subgrade, including the drain, cost $2.66 per linear foot (and, as it happens, also per square yard), leaving $5.79 per linear foot for concrete lining, including the mesh, or $23.16 per cubic yard. All tunnels and the cantilever were connected with the canal lining by reinforced-concrete warped surface transitions.

It was necessary to build about 10 miles of wagon road on the entire work, and to have, at different times, a total of five camps. Excellent meals were furnished at 40c. each, at a loss, and the bunk houses were equipped with steel bunks, mattresses, electric lights, coal stoves with free fuel, and running water. While all this was costly, it was well invested, because the district was able to obtain the best help available, and, what was more important, keep it on the job.

One of the interesting construction features was the sand and gravel plant. The best available material for concrete was in the bed of the Naches River. A suitable bar was found as close to all the work as possible, and here was erected a movable plant, as the bar was long and narrow. The bunkers were of the usual three-bin type, for sand, gravel and crushed rock. A rotary screen, driven by a 10-hp. motor, was mounted on the top of the bin and was fed from a hopper covered with railroad rails spaced 4 in. in the clear, which acted as a grizzly. By means of a 1½-yd. bucket operated as a dragline by a steam-driven stiff-leg derrick with 60-ft. boom, material from the bar was dumped on the rails. Two men were stationed there with poles to push off the very large rocks, which fell into a chute and rolled into a pile back of the bunkers. The other material entered the screen, where the sand

SAND AND GRAVEL PLANT ON RIVER BAR

and gravel were extracted by ⅜-in. and 2½-in. holes, respectively. The tailings dropped into a jaw crusher, operated by a 50-hp. motor, and finally found their way into the third bin. Water was supplied by a 10-hp. motor operating a 2-in. centrifugal pump to keep the sand wet enough to work through the mesh and to facilitate loading the trucks. The bunkers were mounted on rollers and were pulled forward by means of a deadman, wire rope and blocks, with power furnished by the derrick engine. The derrick was backed up as required on greased skids, by its own power. Moving

required about two hours, and was necessary every other day. The plant was operated 12 hours a day by a single shift of five men and kept from eight to twelve 3½-ton trucks busy from 16 to 20 hours per day hauling away material. The hauling was contracted at 40c. per yard-mile, most of it being uphill over earth roads of our own construction and maintenance. It was found that the roads could be kept in fine condition for this heavy hauling by occasional dragging and by daily sprinkling. One man and team were able to do this.

While all kinds of concrete-mixing plants were used to meet the varying conditions, one of unusual interest was a plant built on a steep sidehill at the end of a road so that the trucks were obliged to back onto the material bins and dump in order to turn back on the road. The sand and gravel was fed to a two-bag-batch steam-driven mixer by one man operating control gates, and the concrete was discharged into an open spout which carried it 150 ft. below into a hopper in an inaccessible cañon from which it was loaded into cars by gravity and hauled to place.

Owing to the existing conditions of labor and material, it was impossible to contract this work at reasonable unit prices, and so it was done on a cost-plus fixed-sum basis—under the direct control in all particulars of the chief engineer of the district—by the Nettleton Bruce Eschbach Co. The arrangement proved to be very satisfactory. The general program and designs were worked out by the writer, who was assisted by O. J. Bergoust as field engineer and R. S. Calland as office engineer. Before construction was undertaken, the general program and principal designs were reviewed and approved by D. C. Henny, consulting engineer, Portland, Oregon.

Motor-Vehicle License Fees and Speeds in Iowa

Iowa's new motor-vehicle law, which is designed to supply from $5,000,000 to $6,000,000 annually for highway purposes, prescribes the fees and speeds for the various capacities of trucks, as shown in the accompanying table. The pleasure vehicles are taxed 1% of the factory cost plus 40c. per hundredweight; the tax is payable annually. The speed limit is 30 miles per hour for pneumatic tires and 25 miles per hour for solid rubber tires. Commercial-car schedules are shown in the table. A noticeable feature of the new law is that which requires that in the sale of a second-hand car both seller and purchaser must jointly make application for transfer, and all details, including the new registration, must be complete before the law recognizes the change in ownership as complete.

SCHEDULE OF FEES FOR MOTOR TRUCKS IN IOWA

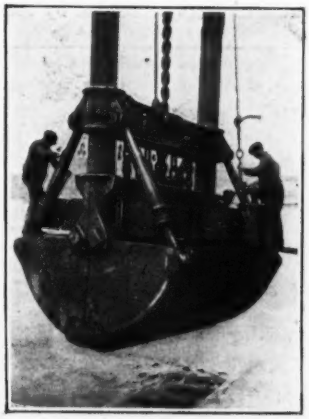
For—	Pneumatic Tires per Annum	Maximum Speed, Miles	Solid Rubber Tires per Annum	Maximum Speed, Miles	Iron, Steel or Hard Tires	Maximum Speed, Miles
1-ton or less capacity	$15.00	30	$15.00	25	$40.00	10
1½-ton capacity	22.50		22.50		50.00	
2-ton capacity	30.00		30.00		No license issued for heavier load capacities.	
2½-ton capacity	45.00		55.00			
3-ton capacity	65.00		75.00			
3½-ton capacity	90.00		100.00			
4-ton capacity	105.00	25	115.00	20		
4½-ton capacity	120.00		130.00			
5-ton capacity	135.00		145.00			
6-ton capacity	165.00	16	175.00	12		
Fees for trailers:						
½-ton capacity	.....	..	.....	..	$3.00	
1-ton or less capacity	10.00	..	10.00	..	15.00	
2-ton capacity	15.00	..	15.00	..	30.00	
3-ton capacity	25.00	..	35.00	..	.....	
4-ton capacity	40.00	..	50.00	..	.....	
5-ton capacity	50.00	..	60.00	..	.....	
6-ton capacity	60.00	..	70.00	..	.....	

Clamshell Bucket Digs Thirty Cubic Yards per Dip

Largest Bucket of This Type Ever Built — Has Record of 24,000 Cubic Yards of Material in Twenty Hours

WHAT is said to be the largest clamshell bucket ever constructed was used in dredging the approaches to a dry dock at Sparrow's Point, Md., for the Bethlehem Steel Co. The bucket, which is shown in the illustration, has a capacity when working in solid mud of 30 cu.yd. per bite. The jaws themselves have a wet capacity of 15 cu.yd. This bucket is said to have a record of 24,000 cu.yd. in two 10-hour shifts.

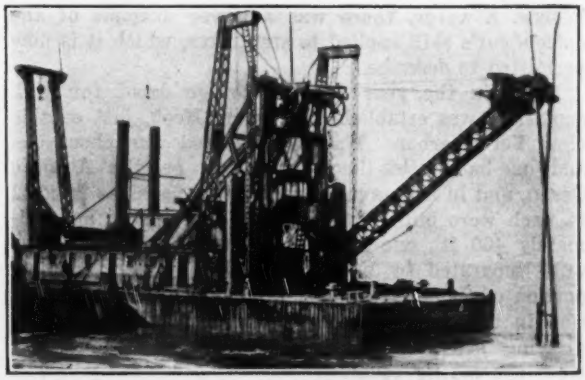
The general dimensions of the bucket may be seen from the size of the men working upon it. The pipe sleeves into which the 90-ft. hickory poles are set, to keep the bucket from twisting, are 16 in. in diameter. The poles pass through ring spreaders upon the mast and keep the bucket in line. Sideboards about 2 ft. high are placed above the jaws, so that when they close they will hold the extra material which rises above the top.



THE SIZE OF THE MEN SHOWS SIZE OF BUCKET

Without the poles the bucket alone weighs 40,000 lb. and in operation it remains open by its own weight. When lowered for a bite the large chain, working through four 30-in. sheaves, closes the jaws. Then the chain and the wire cable, seen attached to the crosshead, work together in hoisting. After the bucket reaches dumping position the chain is released and the jaws open. This chain extends only a short distance above the bucket, where it is attached to another wire cable.

Specially designed scows are required to attend the large dredge shown in the view, since ordinary scows are soon destroyed by the effect of shock in dumping such heavy loads. When the bucket is operating, three



LARGE BUCKETS MAKE SPECIAL SCOWS NECESSARY

1400- and two 1800-cu.yd. scows are in constant attendance. These are of the bottom-dump type.

The bucket was built by the Morris & Cumings Dredging Co., New York City, of which George Leary is president and Fred H. Schomburg is vice-president and secretary.

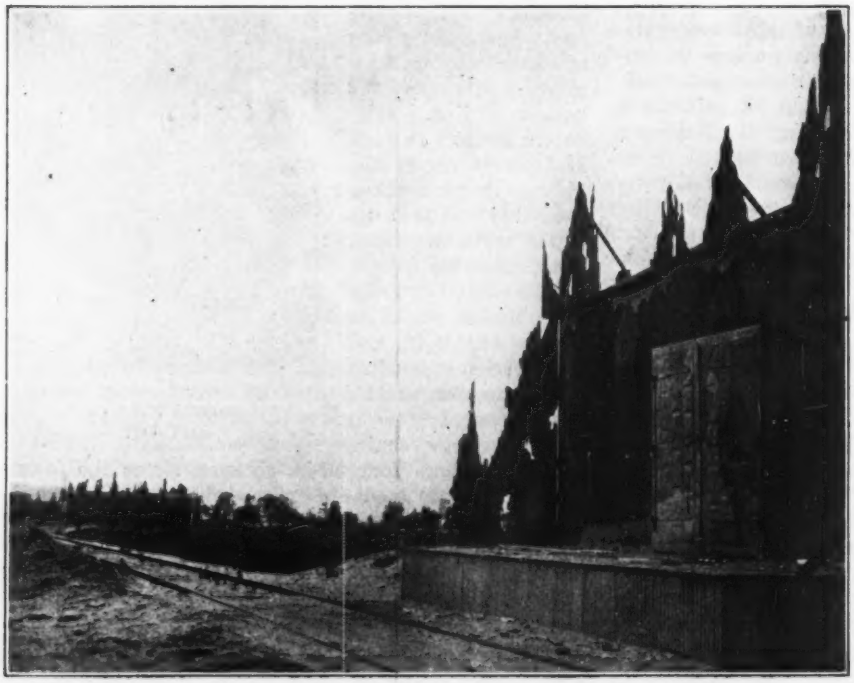
Powder Magazines Made To Look Like Cedar Trees

Sandy Hook Buildings Had to Be Concealed by Camouflage To Deceive Possible German Submarine Raiders

By G. C. Muñoz

Major, United States Army, Chief of Construction Section, Supply Division, Ordnance Department, Washington, D. C.

CAMOUFLAGED ships were familiar to every one who was near an American seaport during the war, but buildings concealed by the new art were rarely seen except by those who got to the war areas. In New York harbor, however, there was a clever example of the camoufleur's skill applied to structures, which it is now permitted to describe.



CAMOUFLAGED POWDER MAGAZINE AT SANDY HOOK—TWO MORE MAY BE DIMLY MADE OUT IN THE BACKGROUND.

Early in the year 1918 a storage depot for high explosives was established at Sandy Hook, just outside New York harbor. The area selected was about one and one-half miles long, bordering on the Atlantic Ocean, and in this area a number of magazines 26 x 42 ft. each were built in two groups and spaced approximately 400 ft., one from the other. The two groups were separated by a space of about 2,000 ft. This portion of Sandy Hook is a sand bar with low vegetation in the southern half and woods and sand dunes growing heavier toward the northern portion. The trees are mostly cedar.

The magazines were built of corrugated asbestos, making the buildings white in color and rendering them exceedingly conspicuous from the ocean. On account of the danger from fire due to combustible underbrush and trees, all vegetation was cleared from around the magazines for a distance of 100 ft. and this clearing, although necessary from a fire-protection point of view, rendered the buildings much more conspicuous from the ocean. As soon as it was established that German submarines could operate along our Atlantic seaboard, it was deemed advisable to render these magazines less conspicuous in order to minimize the danger from bombardment by submarines, and a request was therefore made of the Engineer Corps to send a camoufleur to Sandy Hook to study the problem of camouflaging these magazines and to give instructions to the construction forces as to the best methods of carrying out this work.

After a study of the problem made from a boat, it was decided to camouflage the buildings by making them resemble groups of cedar trees, which was the type of tree found most generally scattered through the depot. This was accomplished by painting vertical blotches of bronze green, light green and mauve with a few horizontal streaks in the lower portion of the building painted light green and sand color. The design in each instance was carried out to resemble so far as possible the immediate background of each magazine and the square lines of the magazines were broken by erection of artificial tree silhouettes built of fire-resisting material and cut and fitted to continue the trees painted on the buildings.

The accompanying view shows very clearly the nature of the surrounding land and the method of camouflaging the buildings in order to make them resemble the surrounding trees. The results obtained were excellent and a man in a boat half a mile from shore cannot detect the presence of these buildings.

Increase in the Use of Motor Vehicles in Chicago

Figures recently made public by the City of Chicago from the records of licenses issued for vehicles under the wheel tax law show that during the last four fiscal years, which ended Apr. 30, 1919, the number of horse-drawn vehicles that were licensed decreased from 49,582 to 32,489, or 34¼. In the same period the automobiles and motor trucks licensed increased from 43,229 to 77,332, or 77¾%. At the end of April there were two and one-half times as many motor vehicles as horse-drawn in the city. The highest percentage of increase during the four years was in motor trucks, buses and coaches of more than one-ton capacity, which increased 164%, while motor delivery wagons increased 104.4 per cent.

Compares Strength of Long-Used and Freshly-Cut Douglas Fir

USING large-sized Douglas fir timbers from the frame of the former city hall of Oakland, Calif., which was dismantled in 1913 after standing for 36 years, a series of 1200 tests was made in the civil engineering testing laboratory of the University of California to determine the strength, elastic properties and moisture content of such timber after long use in a typical frame building.

The original pieces were tested first as beams, using the longest possible span consistent with the sectional dimensions; in general, span length was equal to 10 times the depth of the beam. Broken pieces from the beam tests were sawed into specimens for compression tests, both parallel and perpendicular to the grain, for longitudinal shearing tests and for other beam tests to investigate resistance to impact.

The results of these tests and a comparison between them and tests of freshly-cut Douglas fir are given in extensive tables. Among the conclusions of the author, Arthur C. Alvarez, published in Bulletin 2, Volume 2, of the University of California publications in engineering, it is stated:

For compression parallel to the grain, comparing results of 2 x 2-in. specimens free of defects, all reduced to 12% moisture, the elastic limit of the long-used timber is about 85% of that of the freshly-cut material, but the maximum crushing strength of the former is 3½% greater than that of the latter.

Long-Used Timber Is Stronger

The modulus of elasticity of long-used timber in one case is twice as great as that of freshly-cut Douglas fir. In the other case, when the reduction to 12% moisture is made, the moduli of elasticity are equal. The ultimate strength of the 2 x 2-in. specimens shows that the long-used timber surpasses the freshly-cut timber by about 360 lb. per square inch, or 9%, at the elastic limit, and by 1640 lb. per square inch, or 33%, at the maximum crushing load. A similar comparison for the largest sizes shows that the former are stronger by 300 lb. per square inch, or 9%, at elastic limit, and by 940 lb. per square inch, or 22%, at the maximum crushing load. This comparison shows that the static compressive strength parallel to the grain of air-seasoned timber may increase in time during use under favorable conditions.

The results for longitudinal shear on 2 x 3-in. or 1½ x 3-in. areas show that the long-used timber is stronger than the freshly-cut material by 698 lb. per square inch, or 85%. This shows how greatly the longitudinal shearing resistance of small sections of Douglas fir wood fiber may increase with age, provided defects such as checks, shakes and knots are absent.

The results for compression perpendicular to the grain for the largest size of long-used timber exceeded that for corresponding sizes of air-dry specimens by 243 lb. per square inch, or about 38%. This may be due to difference in moisture content.

The results of the static bending tests on large beams indicate that the static strength in longitudinal shear due to increased seasoning kept pace with the deterioration due to increased checking. Under favorable conditions, Douglas fir of large structural size with ordinary defects does not deteriorate in use when exposed to bending under static loading, but maintains the strength it had in the beginning. Age does not seem to intensify the weakness due to defects.

Impact tests in beams of clear material indicate that Douglas fir after long use is only about 86% as strong at the elastic limit as freshly-cut material of the same moisture content, but is 95% as strong as freshly-cut Douglas fir containing 20% of moisture, a condition which approximates "air-seasoned" on the market. Long use renders Douglas fir fiber slightly less resistant to loading suddenly applied.

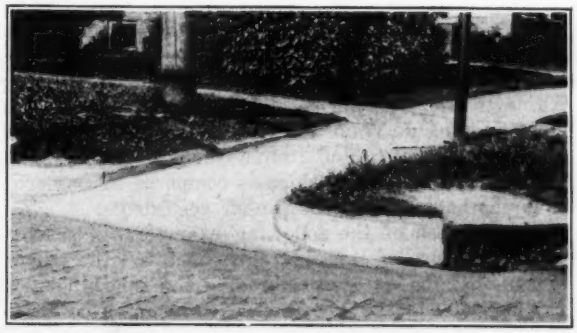
Working stresses for longitudinal shear should be based on the results of tests of specimens similar in character to the details of the timber structure to be designed.

Depressed Cross-Walk Connections Are Convenient for Pedestrians

By C. C. Wiley
Associate in Civil Engineering, College of Civil Engineering, University of Illinois, Urbana

CROSS-WALK connections depressed to eliminate both the step-down type and the crowned cross-walk combine the convenience of the pedestrian with non-interference with vehicular traffic. The accompanying photograph shows the new type of sidewalk-apron crossing which has been adopted as standard on all new work in residence districts in the City of Champaign, Ill.

With a combined concrete curb and gutter, the notch is made in the same way as in private drive entrances. The radius of the curb return is about 1 ft., and sufficient back slope is given to the gutter flag to make a satisfactory water channel. With other types of curbs, the curb can be returned on any convenient radius and the walk made to meet the pavement, with



SIDEWALK APRON AT CROSS-WALK CONNECTION

a somewhat steeper slope for the last foot or so to provide a gutter. The depressed walk is provided with curbs 3 in. wide, built as extensions to the pavement curb returns. The construction as shown costs from $2 to $4 more than the ordinary "jump-down" type.

These approaches are very neat and pleasing in appearance. They provide adequate waterway for ordinary rains, and are no worse in times of unusually heavy rainfall than any of the other types. They offer no obstruction whatever to street traffic, while the full height of the curb at the corner prevents vehicles from encroaching on the parking. At the same time the inconvenient and often dangerous step-down is eliminated, and a smooth, easy approach from either the street or the sidewalk is provided; this is highly ap-

preciated by all pedestrians and especially by women with baby carriages. This crossing was designed by F. C. Lohman, city engineer, of Champaign.

Graphical Method for Estimating Storm-Water Run-Off

By Ralph W. Horner

With Fay, Spofford & Thorndike, Consulting Engineers, Boston, Mass.

THE problem of estimating the quantity of storm-water which may be expected to run off from a given surface area is one which requires considerable experience and good judgment on the part of the engineer. The amount of run-off from a given area is directly dependent on both the amount of rainfall and the imperviousness of the surface over which it flows. At the present time, the rational method of estimating run-off is in quite common use. For its proper application to a given problem the following factors must be known:

1. The area of the surface from which the run-off is to be estimated; (2) the time required for the water to flow over the surface, from the most remote part of the area and through the drainage system to the particular point of concentration under consideration; (3) the intensity of rainfall corresponding to the time of concentration, determined under (1). (This intensity should be obtained from a rainfall curve which is characteristic of the locality being studied.); (4) the run-off coefficient, which is dependent upon the imperviousness of the surface and several other factors.

For use with the rational method, the above factors are combined in the following formula:

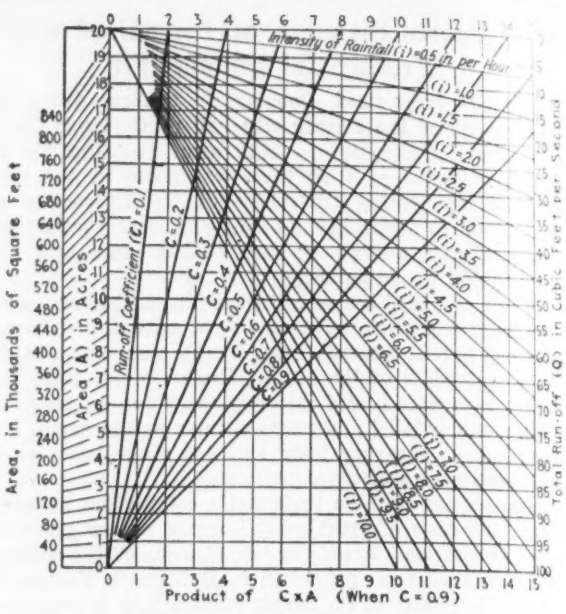
$$Q = c \times i \times A$$

in which Q = the total run-off in cubic feet per second.
c = the run-off coefficient of the area.
i = the intensity of rainfall in cubic feet per second per acre (or approximately the rate of rainfall in inches per hour).
A = the drainage area in acres.

Although this formula is of quite simple solution, the accompanying diagram will be found to be a time-saver in estimating the run-off from a considerable number of areas or from an area which is composed of numerous subareas having different run-off coefficients.

The solution of the following example will serve to explain the use of the diagram: Required the amount of run-off from an area embracing the following parts (a) 350,000 sq. ft. of roof area with a run-off coefficient of $c = 0.9$; (b) 100,000 sq.ft. of sidewalk area with $c = 0.75$; (c) 250,000 sq.ft. of cobble pavement with $c = 0.5$; and (d) 500,00 sq.ft. of filled area, unimproved, with $c = 0.2$. Assume that the time of concentration at a hypothetical point in the drainage system is 15 min. and that the corresponding intensity of rainfall is 3.35 in. per hour.

Enter the diagram on the left-hand side at an area of 350,000 sq.ft., as given under (a); follow diagonally across to the graduations representing area in acres, thus reducing the area in square feet to the corresponding number of acres; follow horizontally toward the right to the diagonal representing $c = 0.9$ and read at the bottom of the diagram the corresponding value of $(c \times A)$ which for (a) equals about 0.7. In the same manner $(c \times A)$ for (b) equals about 1.7; $(c \times A)$ for (c) equals about 2.9; $(c \times A)$ for (d)


Intensity of Rainfall (i) = 0.5 in. per Hour
Area (A) in Acres
Run-off Coefficient (c) = 0.1
Area, in Thousands of Square Feet
Total Run-off (Q) in Cubic Feet per Second
Product of C x A (When C = 0.9)

STORM-WATER RUN-OFF DIAGRAM FOR USE WITH RATIONAL METHOD

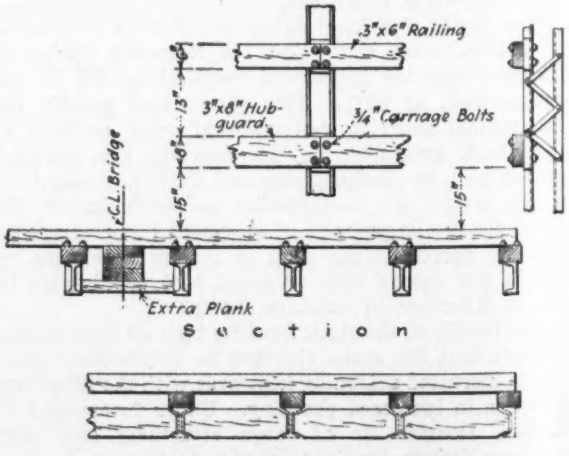
is equal to about 2.3; and the total is equal to about 7.6.

Enter the diagram again at the bottom, where the value of $(c \times A)$ equals 7.6; follow vertically upward to the point where i is equal to 3.35, and from there horizontally across to the right-hand edge of the diagram where the corresponding value of Q is found to be 25.5 cu.ft. per second.

In solving a problem dealing with areas larger than those covered by the diagram, it is only necessary to enter it at the same sequence of figures as those in the given area, and by moving the decimal point the proper number of places to obtain the correct value of Q.

Wheel Guards on Highway Bridges

TO KEEP vehicles clear of trusses of highway bridges, hub guards as part of the railings are preferable to curb timbers on the floor, as the plank floors then keep clean and last longer. This opinion was expressed by C. W. Dewart, bridge engineer, in the 1918 report of the State Highway Commission of Michigan. The construction is shown in the accompanying draw-



ing. Provision is made in these standard bridge plans for extra planks for repairs to be stowed beneath the floor. In reflooring old bridges, heavy strips are bolted to the stringers, and the planks are nailed to these at every intersection. It is explained in the report that this materially reduces the vibration and sway of the trusses and also enables the stringers to carry a much heavier load.

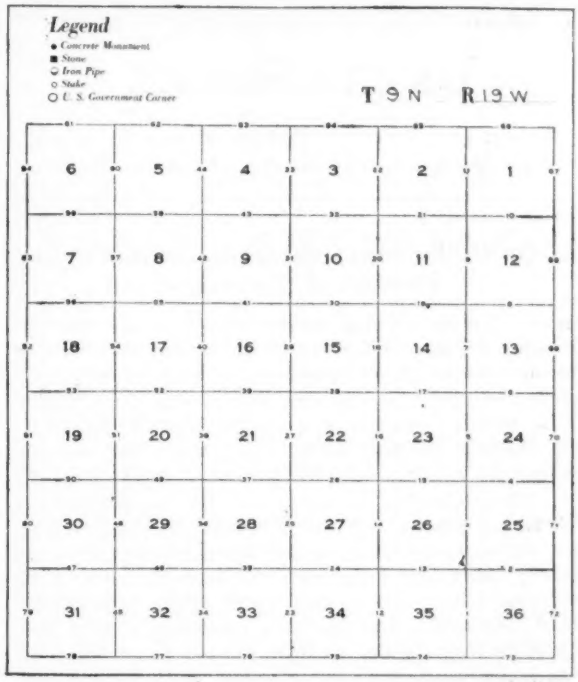
Land-Survey Indexing Plan for County Surveyors

Reference Plat With Loose-Leaf Record Sheets Similarly Numbered Makes Location of Survey Data Easy

By K. Q. Volk
Los Angeles, Calif.

A LOOSE-LEAF indexing system has been developed and found very convenient in making records of land surveys by A. E. Stegman, county surveyor of Kern County, California. The county has an area approximately equal to that of Massachusetts, and each township of 36 square miles has two index sheets as shown, for recording the survey data pertaining to it, the key to the system being the numbered township plat on the back of the sheets.

Referring to the plat and index sheets, it will be seen that the two sets of numbering on the former correspond to that in the left-hand columns of the latter. The sections are numbered from 1 to 36, and the boundary lines of the sections from 1 to 84. The first series of numbers is used to index surveys entirely within the sections, while the second is to index surveys pertaining to the boundary lines of the sections.



TOWNSHIP PLAT WITH INDEX NUMBERS AND MONUMENT LEGEND

Actual size of plat, 8 x 8 inches; printed on back of record sheet

By this means it is easy to locate all surveys which have been made in any section. A record is also kept of the surveyor and of the book which contains the notes.

T 9 N R 19 W

SEC.	NAME	DRAWER	NO.	SURVEYOR	DATE OF SURVEY	NAME	DRAWER	NO.	SURVEYOR	DATE OF SURVEY
1										
2										
3										
35										
36										

T 9 N R 19 W

LINE	DRAWER	NO.	SURVEYOR	DRAWER	NO.	SURVEYOR	DRAWER	NO.	SURVEYOR	BOOK	PAGE	SURVEYOR	DATE OF SURVEY	GOV. NOTES
1														
2														
3														
82														
83														
84														

RECORD FORMS FOR INTERIOR AND BOUNDARY-LINE SURVEYS (Actual size, 10½ by 6 inches)

SOCIETY SERVICE

A Section Dealing with the Results of Teamwork by Technical Men

California State Council of Engineers in Process of Formation

Lack of a central engineering agency for the different sections of California, when an effort was made during the last session of the legislature to reach an agreement on an engineers' license law, has served to crystallize action on the formation of a Joint Council of Engineering Societies of California, to further "the common interest of members of the engineering professions and for the rendering of public service as opportunity offers." A joint committee of seven Los Angeles societies and a joint council of five San Francisco societies already exist and have been functioning. For state problems, however, they soon found their organizations were insufficient, and the San Francisco council proceeded to formulate plans for a state-wide council built practically on the same basis as the two local organizations. The proposal, well worked out in general and ready for the final details, has been sent out for comment and criticism by N. A. Bowers, secretary of the joint council, to nine societies in San Francisco, six in Los Angeles, one in Sacramento and one in San Diego.

The keynote is in the statement of the formulating committee, consisting of C. D. Marx, Edward Higgins, B. S. Drake, C. E. Rogers and E. C. Hutchinson, to the effect that "if engineers are to use their influence to advantage through a state joint council, that body must be representative and it must have some authority." In the proposal it is suggested that representation be restricted to professional organizations, excluding those formed for social purposes; that each society have one representative for each 100 members, with votes equal to the number of active members; that five officers elected at the one annual meeting constitute an executive committee; that an expression of opinion by mail from the membership of each society as a whole on all important questions is to be obtained whenever feasible, representatives being expected to vote the sentiment of their constituency except on minor matters; that expenses of the council, including traveling expenses, are to be apportioned among all societies on the basis of their active membership. Rather than work out representation at large the societies are urged to enroll engineers belonging to no local.

The San Francisco joint council does not consider itself or the Los Angeles joint committee eligible, but it is simply setting the stage and providing the medium until the first organization meeting. In this respect the plan is at slight variance with that proposed by the development committee of the American Society of Civil Engineers, which suggests that the state councils be composed of representatives from the local affiliations, the affiliations to be made up of branches of the national technical societies and the local technical societies. No provision seems to have been made for state societies either in the California proposal or in the development committee plan, whereas in Illinois, the Middle West and West the state societies have followed legislation much more consistently year in and year out than the local organizations. California has made a long step forward toward the consummation of the development committee's plan. It is apparent that it will soon have the machinery to be democratically represented in a national council.

Colorado Engineering Council Working

Under the name of Colorado Engineering Council, eight state and local technical societies have organized to coördinate their work, to promote the welfare and professional standing of their members and to foster a more general recognition of the engineer in civic matters. Each organization has one delegate and an alternate. Two years is the term of office. A representative failing to attend three successive meetings without being excused by the president forfeits his seat. Regular sessions are scheduled at least once a month. The dues are $5 per year for each organization.

One of the first pieces of work was an examination of the license law which was passed by the last legislature, largely through the efforts of the Colorado Society of Engineers, an organization of about 250 members having business and welfare aims. The council was organized too late to do anything with the bill before it became a law, although some of the mining engineers objected quite strenuously to it. Examination by the council into the details, however, disclosed that the law is not bad, and it was decided that, for the time being at least, no opposition to it should be launched.

The officers of the council are as follows: President, Arthur Ridgway; vice-president, L. G. Carpenter; secretary-treasurer, Robert J. Grant, Interstate Trust Building, Denver, Colo.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Large Construction Firms Shun Roadwork

Sir—Just a few added remarks to those of "Practical Engineer" in *Engineering News-Record* of July 3, 1919, p. 38, as to why large contractors shun roadwork. In the capacity of engineer and also of contractor, I have seen the methods of several highway departments.

There are three main items to any engineering project: First, the designing, which naturally falls to the lot of the engineer; second, the building of the project; third, the paying for it. Most anybody (even the Romans) could design and build a structure, but what places the modern designer in the status of an engineer is not his ability to design a structure but, having been given the conditions, to design the structure which will make the investor's dollar accomplish the most.

The writer believes there is a general lack of coordination of the first two items by engineers on highway work. Many highway plans are prepared without a thought of how the work is to be done, what equipment will be used, what equipment is available, the labor situation, the contractors, what equipment should

be used and how the plans can be made to conform to these conditions in order to lower cost and obtain a low bid.

These and many other important features are never considered even by some of our largest engineering departments. We find engineers doing the same things they did twenty years ago. They stick to the old methods of pick and shovel, mule and scraper, and generally make the work a losing game even for these ancient implements.

The work should be designed not only to make a good highway but also to enable a contractor to get the most economical use of his equipment, which will not only result in more competitive bids and more good will but a lower price.

This policy would inevitably result in a better and more substantial road at less or no greater cost. When the plans "chop up" the work and make it a losing proposition for any kind of equipment, an experienced contractor will let the work alone, and the inexperienced one will get the job and lose money or go broke, which is a detriment both to the community paying for the work and the engineer of the project, because a contractor in preparing a bid considers first the reputation of the community, then that of the engineer and his methods and the possibilities of obtaining justice and fair treatment.

A farmer who is a Western state highway commissioner recently remarked at a meeting that what we need in roadwork is less white collars and shirts and more practical men in overalls. I believe he is right, to a certain extent. My Army experience in France and England convinces me that we Americans are too quick to establish large, intricate systems and methods—, where, true enough, everybody is busy and things work in a clocklike manner, but we sometimes make the mistake of calling it efficiency.

Suffice it to say that too often the cost of highway engineering work has exceeded the cost of construction or has been too large an item of expense. There is a limit to engineering expenditure, especially in highway work, and the proper judgment of the engineer should tell him when to stop. Taking all into consideration, one good practical highway engineer of a $250 per month status will accomplish as much satisfactory work as a half-dozen inexperienced men at $125 per month, which latter salary seems to be about all some districts expect to pay. Contractors will not bid on highway work until we have highway engineers, and we cannot get highway engineers at present salaries.

Lincoln, Neb. WILBER J. HOSKYN.

Government Specifications Should Not Misplace Responsibility

Sir—Referring to the letter of E. D. Buel and your added comment in your issue of July 17, 1919, p. 144, with respect to the custom of municipal, state and Federal specifications misplacing responsibility, at least one department of the City of Philadelphia is endeavoring, through its contract specifications, and even through its advertisements for bidders, to assume, as much as possible, the uncertainty of a few of the items which are ordinarily shouldered by the bidders and contractors.

I refer to the Department of City Transit, which, since its creation in 1913, has maintained that bidders and contractors are entitled to whatever information it is possible to accumulate, in order to lessen the element of uncertainty and its attending responsibility, and, furthermore, to obtain the financial benefits to be thus derived.

A few quotations from the publications of this department are self-explanatory and need no enlargement. A specification for the construction of a portion of the Broad Street subway, issued in 1916, contains the following:

> The plans show existing underground structures in accordance with the best information accessible, and should any of such data prove to be so inaccurate or incomplete as to be misleading and involve work not contemplated in the contract, *equitable allowance and compensation will be made therefor.*

In a specification for the construction of column foundations for the Frankford elevated railway, issued in 1915, we find:

> Should any gas or water mains with their chambers or electrical conduits with their manholes, whether shown and noted on the plans or not, or any structure not shown on the plans, require to be moved and relocated in order to clear a pier, such work will be done by the city in the case of city-owned structures, or by the owners in the case of privately owned structures, *without expense to the contractor;* or, if so ordered, the contractor shall do the work as extra under the items in the proposal applicable to the work done. Should the contractor desire to change the location of structures to facilitate his work, such changes shall be subject to approval, and shall be made at the contractor's expense either by the owners or under the owner's supervision.

A third quotation is from an advertisement for station buildings for the Frankford elevated railway, dated April 15, 1919:

> In order to relieve intending bidders of the expense and time involved in taking off the quantities from the plans, a statement of the quantities of material and work as required and covered by the price bid will be issued with the plans and specifications to all bidders. In order that bidders may be assured of the accuracy of the quantities, the statement will be made a part of the contract, and the contractor *will be compensated for any additional work or material that may be required in excess of the statement.*

Philadelphia, Penn. SAMUEL W. BARAKAT.

The Reaction in Engineering Education

Sir—The editorial entitled "Developing the Engineering Mind," in *Engineering News-Record* of July 24, 1919, p. 155, touched on several points in connection with engineering education which have always appeared to be very important to the writer, although he does not agree with all the ideas advanced.

To begin with, it hardly seems possible that the idea of training a student to think can be a "new development" in engineering education. Strange as it may seem, however, it appears that many teachers are just awaking to the fact that the main function of an engineering school is not to fill up a student's mind with a selection from the immense collection of engineering technique which has been accumulated in the last fifty years, but to make him think. As Mr. Allen points out, in the same issue, "with a treatise or textbook as a basis it is natural for a student to depend upon memory." Furthermore, it is undoubtedly true that too many instructors in engineering have looked upon themselves as "drill masters" and have thought that their greatest efficiency was reached when they had so carefully explained some mathematical problem that the students

were letter-perfect in their recitation on it. This has been due to some extent to the survival of ancient teaching methods of the "school of the rod," but the exponents of this method have been aided and abetted by the wave of vocational training which has swept over the country. This mania for problem and laboratory work and for what have been described as "sugar-coated pill" courses has at last produced a reaction, as is indicated by the general tone of the editorials and letters appearing in *Enginering News-Record* during the past year.

From the student standpoint, courses are very popular in which the matter is carefully arranged and is presented by lecture in a very simple way, with interesting applications. Such courses involve little brain work on the part of the student and the instructor is put down as "O. K." On the other hand, the instructor who makes the student "dig it out" for himself, who patiently leads the student to think and reason—who, in short, subordinates himself to the end that thinking and reasoning may be substituted for memorizing—is not always popular, but knows he has done a day's work when he closes his office door at night.

Again, no engineering instructor who has really been "on the job" has entirely neglected the so-called "case system" now advanced as a new departure. Too often an instructor has used practical examples as purely mathematical problems and has neglected entirely the discussions of the "primary assumptions" and other features involved. These things have been dismissed as being settled by that mysterious power known as "engineering judgment," back of which we must not attempt to go. Few students have been brought to realize that real engineering ability does not entirely consist in accurately and rapidly manipulating a slide rule, but in possessing and being able to exercise engineering judgment—knowing how to analyze and weigh the pros and cons of a question and give a scientific opinion of value. Mark Twain once said that "an honest difference of opinion was the thing that made politics interesting." The same is true in engineering, and there is no sense in leading a student to believe that every engineering problem is solved by mathematics and will always have but one answer. The case system is good in moderation, just as "practical problems" are good in moderation, but the minute the problem or case, rather than the fundamental principles involved, becomes the main feature, the instruction degenerates to a form eminently suitable for instructing draftsmen and detailers but not calculated to develop engineers.

Many courses in mathematics and mechanics have been taught with this same tendency, with the result that students can integrate the most involved expression or work out the stresses in a railroad bridge, but the minute a new problem is advanced and they have to analyze the situation and formulate the principles before integrating they are lost. Their grasp of the principles involved is lacking; they are machines for the rapid and exact solution of formulated problems, but they cannot get the data in shape to operate.

It would probably be a very good thing if the engineering schools recognized that at least two kinds of young men were needed in the profession: First, honest, careful, conscientious plodders who will be satisfied to spend their lives as draftsmen and detailers and who have never been educated above their jobs. For such men a vocational type of instruction, such as can be found in most engineering schools, is probably well suited. This is also the type that many narrow-minded practical engineers desire to employ. Second, there is needed the type which broad-minded engineers and educators look to as an ideal—thinking, reasoning beings of power and judgment. Every student who goes to college cannot hope to enter this class, nor can he be educated to it. The qualities required can be developed but not made—they must be present in the raw material.

Thorough and intensive training is essential in the coming "war of efficiency," but the big men of the future must also be broad-minded. The man who goes through life knowing only his own narrow professional field will never raise the status of the engineering profession and is only half living. Economics, business, art, literature and even music, as *Engineering News-Record* suggests, are important. These subjects and even the "principles of architecture" are not entirely "ignored" in all colleges. In at least one institution a brief course in architecture has been given to civil engineering students and has been found to be a valuable feature of the curriculum that may bear fruit in the future.

The space which *Engineering News-Record* has recently given to engineering education and the discussion which has been brought out by this effort cannot fail to lead to important results, and it deserves the thanks of both practicing engineers and the teaching profession.

J. K. FINCH,
Associate Professor of Civil Engineering,
New York City. Columbia University.

Asks Information on Organization of Engineers to Increase Pay

Sir—The Engineers' Club of Columbus, Ohio, has a special committee at work investigating the increasing tendency of the engineering profession to organize in an effort to obtain just compensation for services rendered. This committee asks assistance in the endeavor to obtain such information as may be available pertaining to those organizations that have been completed or are in the process of organizing.

The committee is especially interested in organizations that have not become affiliated with the American Federation of Labor, but which nevertheless have felt it advisable to act collectively.

If possible, we should like to have the name, location and strength of such organizations and the schedule of salaries that each of these bodies recommends, if any recommendation has been made.

Any other information along these lines will be greatly appreciated.

DALE T. WADSWORTH,
Chairman, Committee to Investigate Compensation of Engineers.
117 W. Frambes Ave., Columbus, Ohio.

Accident-Prevention Highway Spurs at Railroad Grade Crossings

Sir—In your issue of July 10, 1919, p. 94, Albert L. Wyman makes three suggestions looking to the prevention of railroad grade-crossing accidents: First, that highway spurs should be built parallel to the track to enable drivers of automobiles approaching a crossing

to turn from the main highway to avoid an oncoming train; second, that a signal to indicate approaching trains should be placed 150 ft. from the track, and, third, that red light signals should be installed at all crossings.

As assistant chief engineer of the California Railroad Commission, the writer had charge of the grade-crossing work of the commission for about three years, during which time every important grade-crossing accident was investigated. An examination was made of every protective device in use or suggested, and nearly all the grade crossings in the state were surveyed. As a result of these investigations, several thousand recommendations, ranging all the way from clearing brush to separating grades, were made to the railroads. Most of them were carried out or were being carried out when the work was discontinued on account of the war.

From this experience the writer is convinced that, except for busy city crossings where gates and watchmen are necessary, the best type of grade-crossing protection is the audible-visible signal, and the first two of Mr, Wyman's suggestions are fundamentally wrong.

Based on their reactions to the grade crossing, there are three types of automobile drivers: The careful and cautious drivers who are always on the alert, the drivers who are willfully careless and deliberately take chances, and, in between, the drivers who are careless through ignorance or thoughtlessness. A grade crossing can never be made safe for a driver of the second class, and a driver of the first class will be amply protected by any device which will protect the drivers of the third class, who are responsible for the greater portion of the crossing accidents that disgrace the country, because they are in an overwhelming majority. The way to reach and protect a driver of this kind is to educate him to the danger of the grade crossing, give him every possible chance to know when he is approaching a crossing, and then to compel him to exercise care whether he wants to or not, because when he gets into trouble he takes, on an average, two others with him.

The highway spur banked to divert safely from the main highway an automobile traveling at 30 miles per hour is an invitation to take a chance which would induce the taking of chances. A driver who knowingly approaches a railroad grade crossing at a speed of 30 miles per hour, or at any speed so high that he is unable to stop after he reaches a point where he can obtain a clear view of the track in both directions, is guilty of nothing less than criminal carelessness. Why go to an enormous expense to aid and abet him? It would be an enormous expense, because 600 miles of highway spurs would be required in California alone to carry out such a plan. The trouble is not that automobile drivers have no chance to escape, but that they place themselves in situations where it is necessary to escape. If all carelessness at grade crossings resulted inevitably in accidents, the number of crossing accidents would be immediately reduced. It is because so many people are careless and "get away with it" that the cautious driver is in a decided minority. A railroad crossing is as dangerous as a drawbridge. Surely the proper way to protect a drawbridge is to require caution when approaching it, and not attempt in any way to make it safe for caution to be thrown to the winds.

In 1916 the grade-crossing committee of the National Association of Railway Commissioners recommended that every grade crossing should be protected by an approach warning signal of a specified type, and California and other states have since passed laws requiring the cities and counties to install such signs at all crossings within their boundaries. Their purpose is not the same as the advance signal advocated by Mr. Wyman, which would indicate the approach of a train, but to notify the automobile driver that he is approaching a spot where there may be danger and that he should govern himself accordingly. The first signal costs $10 per crossing, the second would cost not far from $1000.

The grade-crossing problem is like the problem of squaring the circle—it is impossible of solution. There will be accidents on grade crossings as long as there are grade crossings. The writer's program would be: First, unceasing "safety-first" campaigns by the railroads, the public utility commissions and any civic organization that could be enlisted; second, a crossing sign and approach warning sign at every crossing, the removal of obstructions at the intersections of rail and road, the installation of automatic flagmen, *in the center of the highway* at the more dangerous crossings, and crossing gates and watchmen where they are needed; third, a law, which should be enforced, making it illegal to approach or pass over crossings at a speed exceeding 15 miles per hour.

It is illegal in California to approach a grade crossing at a greater speed than 15 miles per hour when the operator's view is obstructed and to approach a crossing at a speed exceeding 10 miles per hour where the driver's view of the crossing or of the railway traffic within 400 ft. of the crossing is obstructed. This was the program followed by the California Railroad Commission, and the results speak for themselves: Number of persons killed and injured in grade-crossing accidents in California for the year which ended June 30, 1916, 524; June 30, 1917, 384; June 30, 1918, 231.

During 1917 and 1918 motor-vehicle registrations in the state, exclusive of motorcycles, increased 57%, and as most grade-crossing accidents are motor-vehicle accidents it is not unfair to assume that the results were even more beneficial than these figures indicate.

When the program outlined above has been followed, then and not until then should suggestions such as Mr. Wyman's be carried out, and even then it should be borne in mind that when a grade crossing becomes so dangerous that elaborate and expensive means must be taken to protect it, the money can probably be spent to much better advantage by separating grades and abolishing it altogether.

H. G. BUTLER.

San Francisco, Calif.

Design of Swimming Tank

Sir—I was much interested in the article on the design of a swimming tank, by L. R. Viterbo, in *Engineering News-Record* of July 17, p. 135. My attention was particularly attracted to his assumption of 100 lb. per square foot for superimposed live load on the bottom of the tank. I should like to know how much of the 100 lb. was due to the waterproofing and tile, and how much was due to the swimmers in the tank.

New York City. J. S.

[In reply to an inquiry, Mr. Viterbo states that 30 lb. was for the tile and the waterproofing and 70 lb. for swimmers in the tank.—EDITOR.]

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Overcoming Difficulties in Laying Concrete in Cramped Alleys

BY W. W. HORNER
Chief of Division of Sewers and Paving, St. Louis, Mo.

CONCRETE alleys are being constructed in St. Louis this season for the first time. The adoption of this type of pavement has been deferred for several years on account of the difficulty expected in handling and finishing the concrete in cramped locations, with fences, sheds and telephone poles on either side. It was also stated freely that it would be impossible to manipulate it in such close quarters, and that the inverted alley with the center 4 in. lower than the sides, as called for in the St. Louis design, could not be belt-finished. Engineers and contractors, however, have found little difficulty in overcoming these obstacles.

On account of certain soft ledges in St. Louis limestone, it was decided that it would be unsafe to use quarry-run stone in the wearing surface of the alleys.

There is much good stone for this purpose under St. Louis, practically all of the ledges for which the French coefficient of wear will run from 10 to 11. These ledges, however, will alternate with certain soft ledges giving a coefficient of from 4 to 6, and, as handled commercially, these grades are mixed in the crusher.

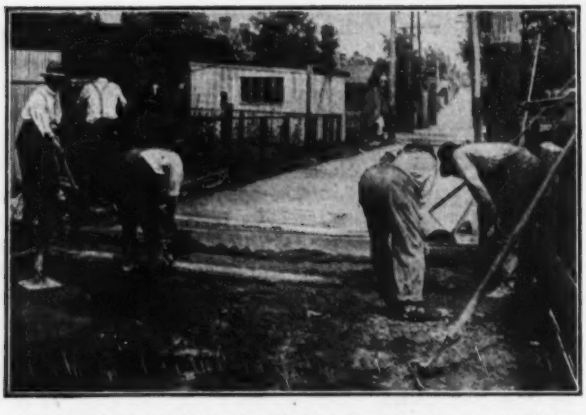
With the idea of using this local stone as far as possible, the specifications permit its use in a bottom course having a thickness of 4 in. and the use of gravel in the top course having a thickness of 2 in. The lower course is a 1:2½:4 mix, and the upper course must be a 1:1½:3 mix. The option is given to the contractor of putting in all of the concrete in one course of the richer mix, but all have preferred to use the two-course work and consider the saving in cement as more than offsetting the additional cost of the two-course organization.

On account of the impossibility of turning the teams in a 15-ft. alley, all materials must be delivered and placed on the subgrade before concreting is started. It has been found rather difficult to distribute properly a limestone aggregate for one course and a gravel aggregate for the other with proportional amounts of sand, and, to the present time, only one contractor has used the limestone in the base.

Considerable difficulty was anticipated in the placing of proper forms at the sides of the alleys, on account of the irregular line of fences and sheds, many of which will vary 6 in. on or off the alley; but this difficulty was overcome by the use of the bar-iron guides, shown in one of the views. These are made of ¾- x 1½-in. strap iron on edge, with the two ends turned over for about a foot and sharpened for driving.

Other Articles in This Issue of Interest to Contractors:

Keeping the Costs of Building the Government Houses — Page 252
Track Elevation on the Indianapolis Union Railroad — Page 265
Reconstruction of the Naches-Selah Irrigation Canal — Page 276
Large Construction Firms Shun Roadwork (Letter) — Page 284
Government Specifications Should Not Misplace Responsibility (Letter) — Page 285



STRIKING SURFACE (NOTE IRON GUIDES AT RIGHT)

FINISHING CONCRETE SURFACE OF ST. LOUIS ALLEY WITH BELT

The irons are 6 to 8 ft. long, and are set sufficiently in the alley to avoid interference with existing structures. They are driven to grade along a line stretched between grade stakes. By slight allowance for the slope of the alley, they may be set as much as 12 or 18 in. out in the pavement.

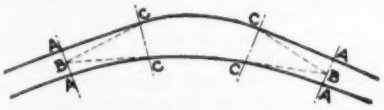
The concrete for the lower course is deposited for a distance of about 15 ft., or the reach of the ordinary boom-and-bucket mixer. It is brought to grade, tamped

lightly and covered with the top mixture, which is struck off with a templet sliding on the iron guides. The guides are set approximately ½ in. high to allow for compacting the concrete by rolling. As soon as the concrete has been struck off, the iron guides are pulled out and the space is filled with wet mortar. A piece of 1-in. plank is laid on top of the conrete on each side of the alley, as a working platform for the roller-man and the belt finishers.

It is found that after the belt becomes wet and the cement coated, it adheres closely to the concrete surface and can be pulled easily from side to side without lifting in the center. On completion of the belt finishing, the side planks are removed, and this strip is finished with a hand float. Nine of these alleys have been completed with very satisfactory results. The average cost of this pavement is about $2 per square yard.

Method of Striking Off Superelevated Highway Curves

WIDENED superelevated curves consist, as indicated by the diagram, of a plane surface CC and two warped surfaces, AC and CA, which connect the plane section with the normal surface of the road approaching the curve. At the two transition sections



METHOD OF STRIKING OFF CONCRETE ON SUPERELEVATED CURVES

the normal line of the crown of the road diverges into two lines, BC. This gives for each section three triangular parts, one, BCC, a plane surface and two others, ACB, which are curved similarly to the normal crown of the road.

To strike off the concrete, drive stakes along the lines BC and on them set to elevation 4-in. channels, flanges down. With these channels as guides, strike off the triangles BCC with a straight-edge. With one channel and the adjacent side form as guides, and using a templet curved to the normal road crown, strike off each of the triangles, ACB. The roller-and-belt finishing operation will round off the ridges along the lines BC and give a warped surface very close to the theoretical elevations.

This method of striking off highway curves is described by William F. Long in the *Concrete Highway Magazine*.

New Device Scoops Up and Loads Asphalt Pavement in One Operation

BY ROBERT H. MOULTON
Board of Trade, Chicago

ONE of the most difficult and tedious jobs with which the engineers of street-railway companies have had to contend has been the tearing up and removal of asphalt pavements, especially the strips lying between the car tracks. There was nothing to do but attack the pavement with picks and axes, and then, when the asphalt had been broken up, load the pieces into wagons or cars with shovels. All of this meant much extra labor, delay and expense in doing the work.

SCOOP COUPLED UP WITH WORK CAR—NOTE DETAILS OF BLADE

Now, however, by means of an apparatus designed by the chief engineer of the United Railroads of San Francisco, the two operations of tearing up and loading the pavements have been combined into one, and the whole thing is accomplished almost with as much ease and speed as peeling a banana.

The new machine is very simple. First, there is a 75-lb. T-rail, which couples with an ordinary work-car. On the T-rail is mounted a scoop or shovel, 34

ASPHALT STRIP REMOVED FROM PAVEMENT SLIDES UP SCOOP IN CONTINUOUS RIBBON

in. wide and 63 in. long, having a sharp, turned-up edge, as shown in one of the views. From the shovel an inclined platform 4 ft. wide and 15 ft. long extends to the car on which the torn-up pavement is to be loaded.

When in operation, the point of the scoop is forced under the asphalt to start it. The car is then started ahead, moving under trolley power, and the strip of asphalt between the tracks is raised up the incline and over the edge of the platform into the body of the car, as seen in the second of the accompanying views. When the car is full it is uncoupled from the scoop and hauled away, another empty car comes up to take its place, and the operation is repeated. By this method great speed in removal of paving is attained.

NEWS OF THE WEEK

New York, August 7, 1919

Tomlin Returns to Editorial Duties

Robert K. Tomlin, Jr., who was captain of Engineers in charge of the Historical-Technical Section, Office of Chief Engineer, A. E. F., has been discharged from the Army and has resumed his duties as managing editor of *Engineering News-Record*.

Captain Tomlin was sent to France as war correspondent for *Engineering News-Record* in the autumn of 1917, his mission being to gather information first-hand of the engineering activities of the A. E. F. and to report them for the benefit of American engineers. He served in that capacity for nearly a year, during which time he covered all of the major engineering activities of our troops back of the front line, his articles, which appeared regularly in *Engineering News-Record*, carrying the only authoritative and complete information on these activities which had at that time come to this country. Just before the Germans started their spring drive of 1918 he covered part of the British front also, preparing as a result of his experience a most comprehensive article on the use of light railways at the front.

In September, 1 18, feeling that the need for officers was great, he asked for release from the staff of *Engineering News-Record* and applied for a commission. He was promptly made a captain and placed in charge of the writing of the history of the American engineering operations in France. That work being completed, he was ordered home in June, and after discharge and a rest of a month resumed his former editorial duties Aug. 1.

Road-Building Materials in Texas

The Texas Highway Department reports that there is a constant inquiry from practically every part of the United States concerning the opportunities for developing road-building materials in the state. These letters are being held until the department can arrange a bureau to oversee the development of road-building deposits in various portions of the state which, the commissioners say, local capital has overlooked.

The need for new sources of material is considered so urgent that the legislature which has just adjourned authorized the Prison Commission to install factories to manufacture road-building materials, with convict labor, if it becomes satisfied that the plan is feasible. Texas is plentifully supplied with raw material for this work, and the deposits are fairly well scattered over the state, it is asserted. In an effort to defeat the high price of cement several counties are contemplating attempts to manufacture this material for the roads they build. It is estimated that the Texas Highway Department will have supervison of approximately $75,000,000 worth of road construction during the next two years.

Employment Bureaus

Engineering Societies' Employment Bureau of the four founder societies, conducted by Engineering Council Employment service, for members and for other professional men introduced by members. Especial attention for those released from Government service. Address, 29 W. 39th St., New York City.

American Association of Engineers, 29 S. La Salle St., Chicago. Service to members only, but Army or Navy Engineers in uniform who are eligible to certified membership may join without payment of entrance fees or dues while in uniform and for six months after discharge.

Engineers' Service Bureau, 57 Post St., San Francisco. Only applications by mail or wire will be considered.

Professional and Special Section, United States Employment Service, 469 Fifth Ave., New York City.

Reëmployment Committee of New York City for Soldiers, Sailors and Marines, 505 Pearl St.,

Wires Returned to Owners

On July 31, 1919, after just a year of Government operation, the telegraph and telephone systems of the United States were returned by Postmaster General Burleson to the companies owning them.

Daylight Saving Repeal Again Up

The Senate this week by a vote of 41 to 12 passed the bill (H.R. 3854) repealing the daylight saving law. The House passed the bill June 18, but action upon it in the Senate was suspended until this week. Meanwhile, the President vetoed the rider in the agricultural bill and the House was unable to enact it over the veto. The repeal bill differs from the rider in that it does not do away with the provisions regulating standard time. It is expected that the President will veto the bill now before him, as his former veto advanced his reasons for his failure to approve the measure.

Railway Brotherhoods' Plan for Railways

Government Ownership With Voice in Management and Profit Sharing for Employees and Officers

By the action of the railway labor organizations a new element has been injected into the current discussion of the railway problem now before Congress for solution. The heads of the organization have served notice on the Federal Railroad Administration that unless some measures are taken to reduce the cost of living, railway labor all along the line must have a further wage increase sufficient to raise the operating expenses of the railways some $800,000,000 a year. Railway repair-shop workmen have already begun strike for increased wages. The net income of the railways under Federal control during the first six months of 1919 was only $157,000,000. Hence, increased freight rates or huge appropriations from the Federal treasury are the only means by which such large increases of wages could be granted.

Oppose Return to Owners

At the same time, the railway labor leaders have announced their opposition to the return of the roads to the companies, and demand the adoption of the plan for reorganization of the railways prepared by Glenn E. Plumb, counsel to the railway brotherhoods. In a public statement issued Aug. 2 the heads of the brotherhoods say, "the railroad employees are in no mood to brook the return of the lines to their former owners, since all the plans suggested for this settlement of the problem leave labor essentially where it has stood and where it is determined not to stand."

The Plumb plan, which is now before Congress in a bill introduced by Congressman Sims, provides for the taking over by the Government of the entire railway system at a valuation to be fixed by the courts. The Government would lease the entire property for operation to a corporation with 15 directors, five to be appointed by the President, five elected by the railway officers and five by the railway employees. This corporation would have no capital and the directors would really be a board of trustees.

The corporation would pay from its earnings the operating expenses and the fixed charges on the purchase price paid by the Government. The balance remaining would be divided equally between the Government and the corporation, and the corporation would use it to pay a profit-sharing dividend to the officers and employees.

Rates would be fixed by the Interstate Commerce Commission and whenever the corporation's share of net earnings exceeded 5% of the gross operating revenue in any year the commission would reduce the rates. The cost of extensions would be met in whole or part by assessment on the property benefited.

In a published statement by Mr. Plumb he says that an essential feature in the success of this plan is the correct interpretation of valuation. He says: "It is the contention of the organized railway employees that the only basis for valuation is the amount of money the railways have actually invested in the public service. This principle eliminates fictitious securities and improvements paid for out of surplus. This would probably decrease the assumed valuation of the railroads from approximately $18,000,000,000 by at least one-third."

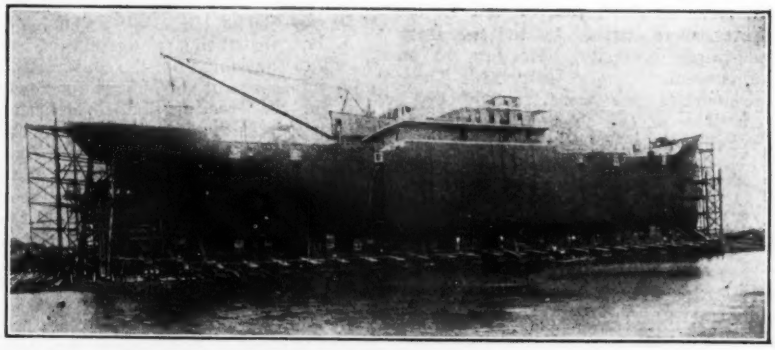
In order to force the Plumb bill through Congress, the railway brotherhoods have effected an organization of which Warren S. Stone, chief of the Brotherhood of Locomotive Engineers, is the head. It is declared that organizations representing over 6,000,000 voters, including the American Federation of Labor, have already indorsed the Plumb plan, and that branch organizations in every Congressional district will bring pressure to bear upon individual Congressmen to induce them to vote for its adoption.

Mondell Soldier Settlement Bill Reported in House

A National Soldier Settlement Fund of $500,000,000, "to provide employment and rural homes" for soldiers and sailors who served in the late war, will be created if the Mondell bill (H. R. 487), favorably reported to the House Aug. 2 passes Congress and is approved by the President. The bill embodies Secretary Lane's project for farms for soldiers and sailors, which has been before the country for months past. It authorizes the Secretary of the Interior to acquire and reclaim or develop land for the purpose indicated, going so far as to make the land ready for cultivation, "including the building of essential public roads." So far as possible, soldiers and sailors will be used for the necessary reclamation work. The farms will be sold to soldiers and sailors for 5% cash, the balance to be paid within 40 years, with interest at 4%. Loans up to $1,500 for farm improvements and $12,000 for livestock and equipment are authorized. Any state coöperating with the United States in providing these rural homes, and furnishing 25% of the necessary funds, will be permitted to carry out the improvements and aid, subject to the supervision of the Secretary of the Interior. The Mondell bill, as outlined above, is one of some twenty before Congress for the same general purpose, but interest has seemed to center in it.

First Government Designed 3500-Ton Concrete Ship Launched

On July 31, 1919, the first of the 3500-ton concrete ships designed by the concrete ship section of the Emergency Fleet Corporation was launched at the yard at Wilmington, N. C. As shown in the accompanying view of the boat on the ways, it was launched sideways and slipped into the water without difficulty. As described in *Engineering News-Record* of July 4, 1918, this ship, which was christened the "Cape Fear," is 282 ft. long, has 46 ft. beam and 28 ft. 3 in. molded depth, and has a dead-weight carrying capacity of 3500 long tons. The following data regarding the launching are reported by the shipbuilding company:



3500-TON CONCRETE SHIP "CAPE FEAR" JUST BEFORE LAUNCHING

Average pressure on the grease immediately before the launching, approximately 5 long tons per square foot.

Maximum pressure during the launching, which occurs as the vessel pivots on the ways, about 13 tons per square foot.

Inclination of the ways, 1¼ in. per foot.

Distance from center line of ship to end of ways, 35 feet.

The ship was built by the Liberty Shipbuilding Co., Lewis R. Ferguson, general manager, as superintendent for the United States Shipping Board, Emergency Fleet Corporation.

Five States Memorialize Congress For Greater Federal Aid

Governors of five states, Kansas, Texas, Oklahoma, Nebraska and Iowa, have memorialized Congress for increased Federal aid. The memorial was unanimously adopted at a meeting held in Kansas City July 31 by representatives of the highway departments of the states named.

The meeting was called at the suggestion of Gov. Henry J. Allen, of Kansas, who acted as chairman and stated the necessity for obtaining additional Federal aid. He supported his claim by the fact that Kansas counties now have appropriations for such aid amounting to $16,000,000, less than $8,000,000 of which is available, because it was appropriated with the stipulation that the Federal Government should supply one-half the amount used. It developed at the meeting that each of the other states represented was in a similar situation. Texas, in particular, has voted more than $60,000,000 in county road bonds with the understanding that an equal amount of Federal aid would be available, yet only $10,000,000 of this aid is now available. Arkansas and Missouri, while not represented at the meeting, sent telegrams, through their state highway departments, indorsing the action of the other states. The memorial requested that additional funds to the amount of $400,000,000 be available for hard roads in the next five years.

The representatives of the states at the meeting were as follows: Kansas, Gov. Henry J. Allen, chairman of the State Highway Commission; A. C. Blair, commissioner; W. C. Markham, secretary to the commission, and M. W. Watson, state highway engineer; Texas, C. S. Fowler and R. M. Hubbard, commissioners, and R. J. Windrow, highway engineer; Oklahoma, State Senator Colobie, representing the Governor; Henry Wood, commissioner, and E. W. Foster, representing the commission; Nebraska, George E. Johnson, highway engineer; Iowa, J. W. Holden and William Collinson, commissioners, and F. R. White, state highway engineer. The last-named acted as secretary.

Roads in the National Forests

Through provisions in the Federal-aid road act and the postoffice act, the forest service of the Department of Agriculture has at its disposal a sum of $13,500,000 which will be spent this year on survey, improvements and construction of 3368 miles of road in the national forests. About 270 projects in road maintenance and construction are now under way, approximately 75 of which are major projects in the Northwestern states. The building of new roads in the national forests will open up natural resources which have heretofore been inaccessible, it is stated. In addition, some necessary links in transcontinental highways will be provided. It is estimated by experts of the forest service that $100,000,000 is needed to construct and maintain adequate roads in the 153 national forests.

Referendum Vote on Return of Railways to Owners

Nine of ten recommendations involving the return of the railroads to their owners by the Federal Government, and other questions of railway policy, submitted to a referendum vote by the Chamber of Commerce of the United States, were carried by the necessary two-thirds majority, according to an announcement made July 28. These recommendations were framed by a committee of the chamber's committee on railroads after a conference with more than twenty men chosen by the committee as representatives of various interests affected by railway transportation. Among the eleven committeemen who signed the report were Charles Lee, consulting engineer, New York City; Walter S. Dickey, manufacturer, St. Louis, Mo.; Emory R. Johnson, professor of transportation and commerce, University of Pennsylvania, and George A. Post, New York City, formerly president of the Railway Business Men's Association, who was chairman of the committee. Over 1100 commercial and industrial organizations, distributed through 48 states, took part in the vote. The 10 questions submitted, with the votes, follow:

1. Adherence to the policy of corporate ownership and operation, with comprehensive regulation, 1439 to 12.

2. Return of roads to corporate operation as soon as remedial legislation can be enacted, 1439 to 12.

3. Adherence to the period of Federal control as now fixed unless and until the impossibility of remedial legislation in this period clearly appears, 1329 to 109.

4. Permission for consolidation in the public interest, with prior approval by Government authority, in a limited number of strong competing systems, 1293½ to 123½.

5. Requirement that railroad companies engaging in interstate commerce become Federal corporations, with rights of taxation and police regulations reserved for states, 1215 to 184.

6. Exclusive Federal regulation of capital expenditures and security issues of railroads engaged in interstate commerce, with provision for notice and hearing by state authorities, 1321½ to 85½.

7. Federal regulation in intrastate rates affecting interstate commerce, 1314 to 114.

8. A statutory rule providing that rates in each traffic section shall yield an adequate return to a fair value of the property as determined by public authority, 1206½ to 208½.

9. [Not carried.] Payment into a fund of a share of the excess earned by any railroad system, under application of the above statutory rule, over an equitable minimum return upon the fair value of the property, this fund to be used as Congress directs for strengthening general railroad credit and increasing general railroad efficiency, 850 to 540.

10. A Federal transportation board to promote development of a national system of rail, water and highway transportation and articulation of all transportation facilities.

Pennsylvania Adopts a System of Rewards for Roadwork

A law instituting a system of rewards to townships for the construction and improvement of township roads and for the erection and construction of township bridges in townships of the second class has been signed by Governor W. C. Sproul of Pennsylvania. An appropriation of $1,000,000 has been made available for this purpose by the new law, which takes the place of that which provided for bonuses of 50% of the amount expended by townships on the work.

By the terms of the new law the State Highway Department will pay rewards when the work has been completed by the township. Rewards will be granted by the township for improvements of the following nature covering a distance of ¼ mile of road: (1) Grading and draining; (2) gravelling or cindering a graded and drained road; (3) macadamizing or construct ing telford road; (4) constructing a concrete, brick or bituminous road surface; (5) erection and construction of bridges 3 ft. or more in span, of concrete or stone or combinations of concrete and stone; (6) constructing steel bridges with a floor approved by the State Highway Department; (7) purchase and installation of culvert and drain pipes.

The rewards are to equal 33⅓% of the cost of the proposed improvement, the basis of reward being roads 16 ft. in width.

Highway Bill Calls for Extension of Federal Aid

A bill introduced in Congress, H. R. 4377, calls for the continuation of Federal aid for roads, with amendments, and appropriates $100,000,000 to be available June 30, 1920, and $300,000,000 each for 1921, 1922 and 1923, making a total appropriation of $1,000,000,000. A Senate bill, S. 1037, provides for the granting to the State of Colorado of public lands to aid in the construction and maintenance of public roads and in the study of forestry. This bill grants to the state all unreserved nonmineral public lands within the state, the proceeds of sales to be used as follows:

One-fourth to go to the construction and maintenance of public wagon roads and bridges, one-fourth to the State University to encourage and promote the study and solution of the problems of forestry, one-fourth to the agricultural college to promote the study of horticulture, and one-fourth to be used by the State Normal School to promote vocational education, train teachers, etc. It is provided that none of the land shall be sold for less than $2.50 per acre.

Five-Million Dollar Contract for Hetch Hetchy Dam

Bids for the construction of the large Hetch Hetchy dam for the San Francisco water-supply, described in *Engineering News-Record* of July 31, 1919, p. 244, were opened on July 31, 1919. Only two bidders submitted figures. R. C. Storrie & Co. submitted a total bid of $5,431,010 for the overflow spillway type and $5,475,910 for the siphon spillway design, in both cases the contractor to furnish the cement. On these same propositions the Utah Construction Co. submitted bids of $5,370,808.50 for the overflow spillway and $5,447,792.50 for the siphon spillway. The latter company also made a bid without the cement.

The contract was awarded to the Utah Construction Co. for the siphon spillway design.

There was great interest manifested in the opening of the bids, over 100 contractors being present.

Concrete Barge Sinks at Dock

One of the Railroad Administration's concrete barges operating on the New York Barge Canal sank at the dock at Tonawanda July 29, carrying down 15,000 bushels of wheat. Reports of the occurrence are vague, but it appears that the barge came in contact with a bridge pier just before docking, which may have punched a hole in the shell. Investigations of the accident are under way.

Higher Pay for Chicago Engineers

In the large salary increase included in the new budget of the City of Chicago, the engineers appear to have received substantial recognition. Owing to the activities of the local branch of the engineers' union, all engineers up to Grade 3 (division engineer) were granted rates according to a schedule adopted by the union. This union has not yet included the higher grades, but the engineers in those grades have received an increase of approximately 10 per cent.

Motor Trucks Are Earning Large Wages in Texas Oil Fields

One hundred dollars for a haul of 42½ miles would be considered a large wage for motor-truck drivers in the north, but it is just an ordinary day's return in the newly opened oil field in northern Texas, according to reports.

However, the trucks have to operate over a very difficult territory, which is practically prairie, and it is doubtful whether the rates which are now in force will be lowered in the near future. For instance, the route lying between Moran, Tex., and Park Field is traversed by trucks carrying loads averaging 12,000 lb. each over trails and roads in what can be considered little less than unbroken country. In addition to the capacity load of the trucks themselves, practically all trucks take

trailers. With these trailers the trucks carry the long oil-well casings so necessary to the well drillers of the oil region. Many of these trucks and trailers are now being equipped with collapsible bodies which will be used to haul grain on the return trip, thus adding materially to the profits of the truck drivers, as well as moving part of the present crop of wheat.

Railway Engineers Get Higher Pay

Consideration of the request for higher pay for engineers in railway service was transferred some time ago by the United States Railroad Administration from the Wage Board to the regional directors, and R. H. Aishton, of the Northwestern region, has authorized the increase specified in the schedule submitted, for all grades below chief draftsman and assistant engineer. Other regional directors have the matter under consideration.

Licensing Engineers in Idaho

Enforcement of regulations governing the practice of surveying and civil engineering in Idaho now comes under the commissioner of law enforcement, R. O. Jones, Boise, under a state law regulating the practice of civil engineering, which appears to include all branches of engineering except mining and metallurgy. An examination for civil engineers will be held Sept. 9, and that for surveyors Sept. 2. Since June, 1903, no land survey or plan has been legal in Idaho unless made by a licensed surveyor.

More Water Filters for Cleveland

A start is being made on plans for the proposed new east side water-filtration plant for Cleveland. The plant will be of the mechanical filtration type and will be built adjoining the site of the Baldwin reservoir. Excavation for the latter will be completed this year, which will permit the starting of the filtration plant construction early next year, it is expected. J. T. Martin is water commissioner and A. V. Ruggles is engineer of construction and surveys, Division of Water.

Civil Service Examinations

United States

For United States civil service examinations, listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Master computer, $2400 to $1800 per year, computer (Grade I) $1800 to $1400 and computer (Grade II) $1400 to $900, Ordnance Department. Applications will be received until further notice.

Electrical assistant, signal service at large, War Department, for duty at Manila, Philippine Islands, $1500 to $2000 per year. File applications before the close of business on Aug. 19.

Technical assistant, field of civil engineering, $3200 per year, and technical assistant, torpedo design, $3000 per year. File applications by Aug. 19.

Supervising draftsman, bureau of steam engineering, Navy Department, $12.80 to $13.60 per diem. Applications must be filed before August 19.

Patent investigator, patents section, War Department, $1200 to $1800 per year. File applications before August 26.

Expert patent investigator, patents section, War Department, $1800 to $2400 per year. File applications before Aug. 26.

Chief metallurgist, $4,500 to $5,000 per year; assistant chief metallurgist, $3,600 to $4,500 per year, Ordnance Department. Applications must be filed before Sept. 16.

Electrical engineer, $2,400 to $3,600 per year; assistant electrical engineer, $1,800 to $2,400 per year, Signal Service. File application before Sept. 16.

Specification engineer, $2,400 per year; Chief Signal Officer's Office, War Department. File application before Sept. 9.

Research engineer, $2,800 to $3,200 per year, Ordnance Department. File application before Sept. 2.

Plant superintendent, $2,000 to $2,400 per year, Ordnance Department. File application before Sept. 2.

Electrical engineer, $2,800 to $3,300 per year, Bureau of Standards, Department of Commerce. File application before Sept. 2.

Research physicist, $2,700 to $3,200 per year, Ordnance Department. File application before Sept. 2.

Radio engineer, $3,000 to $4,800 per year; assistant radio engineer, $2,000 to $3,000 per year; radio laboratory assistant, $800 to $2,000 per year, Signal Service, War Department. File application before Sept. 2.

Mathematics and dynamics experts, Grade I, $2,500 to $4,000 per year; Grade II, $4,000 to $5,000 per year, Ordnance Department. File application before Sept. 2.

New York State

Inspector of engineering work, county service, $960 per year. File applications before Aug. 20; Sanitary engineering inspector, State Department of Health, $1,260 per year. Applications must be filed not later than Aug. 20. Statistician, Bureau of Statistics and Information, State Industrial Commission, $1,500 to $1,800 per year. Applications must be filed before Aug. 20; Albany, N. Y.

ENGINEERING SOCIETIES

The Engineers' Club of Minneapolis was addressed July 26 by Theodore Wirth, superintendent of parks, Minneapolis, who spoke on the improvement of city parks. The club adopted a resolution to support the campaign to create a department of public works.

The Engineers' Society of St. Paul held a special meeting July 31, to discuss the bill now before Congress, creating a department of public works, and passed a resolution approving the bill.

The New York Chapter of the American Association of Engineers has established permanent headquarters in the St. James Bldg., 1133 Broadway, New York City.

The American Chemical Society will hold an autumn meeting Sept. 2-6, at the Bellevue-Stratford Hotel, Philadelphia, Penn.

The Utah Chapter of the American Association of Engineers is in process of organization, Prof. F. H. Newell, president of the association, having gone to Salt Lake City at the end of July to complete the organization.

The American Institute of Mining and Metallurgical Engineers will hold its annual meeting at Chicago, Sept. 22-26. The progress that has been recently made in technical lines will be fully discussed. Among the subjects that will receive particular attention will be the iron and steel industry, which has reached such importance in Chicago and its vicinity. It is planned that the institute will make an excursion to Gary, Ind., during the meeting. Arrangements are being made to charter a steamer which will convey the members and guests across the south end of Lake Michigan directly to the steel works. Technical discussions on metallurgy will be held on the boat. The banquet has been scheduled for the evening of Sept. 24, at the Congress Hotel.

Calendar

Annual Meeting

NEW ENGLAND WATER WORKS ASSOCIATION Tremont Temple, Boston, Sept. 30, Oct. 1-3, Albany, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION; 169 Massachusetts Ave., Boston; Oct. 27-30, New Orleans.

PERSONAL NOTES

PREVOST HUBBARD has resigned as chief of the division of tests and research, United States Bureau of Public Roads, to become associated with the Asphalt Association, New York City, as chemical engineer, with headquarters at 15 Maiden Lane, New York City.

CHARLES B. SPENCER, who has just returned from France, where he served a year with the American Expeditionary Forces, has become a member of the new firm of SPENCER, WHITE & PRENTIS, INC., engineers and con-

tractors, of New York City. Mr. Spencer for eight years was in the employ of the Underpinning and Foundation Co., of New York City, in which capacity he had charge of many large construction operations.

LAZARUS WHITE, who was recently released from war work, mainly in the Construction Division of the Army, has become a member of the new firm of SPENCER, WHITE & PRENTIS, INC., engineers and contractors. Mr. White was engaged on the Catskill Aqueduct during the entire course of its construction, and since 1914 was connected with Smith, Hauser & MacIsaac, Inc. For them he carried to successful completion on William St. one of the most difficult of the New York subway sections.

EDMUND A. PRENTIS, JR., recently released from active duty in the Navy, has joined the new firm of SPENCER, WHITE & PRENTIS, INC., engineers and contractors, of New York City. Mr. Prentis was a mining engineer in South America and Mexico until 1912, when he entered contracting in New York. He was superintendent of the underpinning of buildings along two Broadway sections of the New York City subway for the Underpinning and Foundation Co., and later for Smith, Hauser & MacIsaac, Inc., he designed and installed difficult underpinning along the William St. section.

W. S. BURNETT, district engineer, Springfield, Ohio, has resumed his duties as engineer maintenance of way on the Cleveland-Sandusky division of the Cleveland, Cincinnati, Chicago & St. Louis Ry., with office in Springfield, Ohio.

CAPT. JOHN B. NORRIS, JR., 51st Engineers, U. S. A., has returned from France after 27 months' service, and has received his discharge. Captain Norris will become associated with the Ellicott Machine Corporation, builders of hydraulic presses, Baltimore, Md.

EDMUND MORTIMER BLAKE has been appointed production engineer, Charles R. McCormick & Co., Fife Bldg., San Francisco, Calif. Mr. Blake is a graduate of Amherst College and of Lawrence Scientific School of Harvard University; during the war he was engaged in shipyard construction as supervisor of subcontracts on the Victory destroyer plant at Squantum, Mass., and later as assistant manager of the Liberty shipyards, at Alameda, Calif.

MCLEAN & WHEATON, contractors, have enlarged the firm by admitting GEORGE DEEKS into partnership, the new firm being known as the DOMINION CONSTRUCTION CO. & WHEATON, with headquarters at Moncton, N. B. Mr. Deeks was previously connected with Deeks & Hinds, Toronto, and the Toronto Construction Company.

CAPT. R. FRASER ARMSTRONG, Canadian Expeditionary Forces, has been appointed town manager, Woodstock, N. B. Captain Armstrong is a graduate of the University of New Brunswick and a postgraduate of McGill University. He was awarded the M.C. during the allied drive of 1918.

J. E. KISSEL, acting engineer maintenance of way, Cleveland and Indianapolis division, has resumed his duties as engineer maintenance of way, Cairo division, Cleveland, Cincinnati, Chicago & St. Louis Ry., at Mount Carmel, Ill.

W. J. PARSONS has formed a new company, of which he is president, to be known as the W. J. Parsons Housing Co., specialists in housing problems, 1616 E. Monadnock Bldg., Chicago. Mr. Parsons has had long experience in housing problems for industrial companies, having built the houses for the American Bridge Co., Gary, Ind. He also had charge of some of the heaviest construction work on the Hell Gate bridge. Since then he has been associated with the Foundation Co., as assistant local manager, Pittsburgh; with the Koppers Co., Chicago, as resident engineer, and with the Southeastern Housing Corporation as chief engineer.

O. C. TENNYSEN, general foreman in charge of steel structure, Chester Shipyards, has formed a company under the firm name of the Tide Contracting Co., 2016 Lippincott St., Philadelphia, Penn.

C. F. HINCHMAN has received his discharge from the service and has resumed his work as engineer maintenance of way, Indianapolis Terminal division of the Cleveland, Cincinnati, Chicago & St. Louis Ry., with office in Indianapolis, Ind.

CAPT. CHARLES E. ELLICOTT, JR., 105th Engineers, U. S. A., has returned from France after two years' service. Captain Ellicott will become associated with the Ellicott Machine Corporation, builders of hydraulic dredges, Baltimore, Md.

L. B. ELLIOTT, formerly engineer maintenance of way, has been appointed acting engineer maintenance of way, Peoria & Eastern division of the Cleveland, Cincinnati, Chicago & St. Louis Ry., with office in Indianapolis.

FRANCIS L. BENNETT has become associated with the Boldt Construction Co., general building contractors, Cleveland, Ohio, as estimator.

FRED W. FISCH has been appointed assistant sanitary engineer, Flint, Mich.

ARTHUR G. GEHRIG, structural engineer, Western Electric Co., Chicago, has been appointed associate professor of civil engineering, in charge of structural engineering, at the University of Nebraska. Professor Gehrig was formerly connected with the American Bridge Co. at the Panama Canal on the construction of the Balboa shops, emergency dams, and the Navy coaling station.

W. C. KEGLER, previously district engineer, Cleveland, Cincinnati, Chicago & St. Louis Ry., has been appointed engineer maintenance of way, Cleveland and Indianapolis division, with office in Galion, Ohio.

HARVEY SNOOK, recently returned from France, has been reappointed county engineer of Sussex County, New Jersey.

F. E. POWERS, J. E. SCHLOTTMAN, and W. B. MCCOOL, having returned from France and received their discharge from the Engineers, United States Army, with rank of captain, have become associated under the firm name Ajax Contracting Co., Pottsville, Penn., and will engage in general contracting work.

H. W. HOUGHTON has resigned from the engineering department of the Kansas City Ry., at Pittsburg, Kan., to become associated with the Nebraska state highway engineering Department, as designer, at Lincoln.

GEORGE S. HUBBEL, chief engineer, PRUDENTIAL ENGINEERING CORPORATION, will take charge of the New York office of this company, which will be located at 131 W. 39th Street.

HERBERT M. HALE, consulting engineer, has opened an office at 7 E. 42nd St., New York City. Mr. Hale will engage in general engineering, examination and reports, and general contract work.

MAJ. H. A. MCPHERSON, of the 11th Battalion Canadian Engineers, has been appointed advisory engineer to the Canadian Government. Major McPherson, besides being advisory engineer to the Bureau of Public Health, will also act as advisory engineer to the Local Government Board. He served for three years at the front with the Canadian Engineers.

OBITUARY

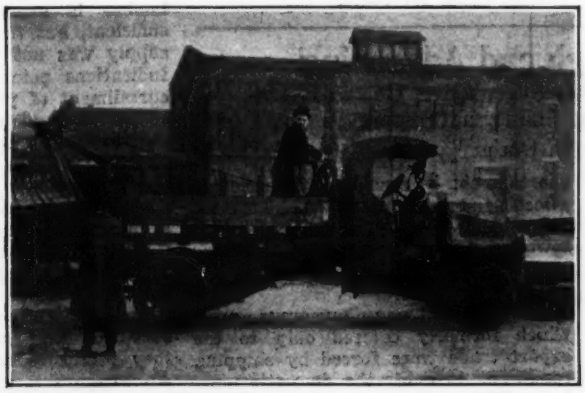
ALFRED FARRAND, city engineer of Ventnor City, N. J., died Aug. 4. Mr. Farrand had been city engineer of Ventnor City for five years, and prior to that he was city engineer of Atlantic City for 15 years.

LA VERNE W. NOYES died in Chicago, July 24, at the age of 70. He was graduated from Iowa State College in 1872, and later received the honorary degree of doctor of engineering from that institution. Mr. Noyes had been president of the Aërmotor Co., and the Illinois Manufacturers' Association. He was interested in farm machinery, and perfected and patented the tilting towers for windmills. Later he formed the Aërmotor Co. Mr. Noyes made an endowment to the University of Chicago of over $2,000,000 to be devoted to the education of soldiers, sailors and their families.

Motor Truck Wrecker Has Wide Range of Utility

A large motor truck wrecker used by the Boston Fire Department has a wide range of usefulness aside from its business of picking up wrecked fire apparatus. In fact, the big machine, which weighs approximately seven tons, is equipped with all kinds of jacks, bars, shovels, chains, ropes and repair tools, making it in reality a traveling machine and repair shop. It has a power winch and derrick that lifts 10 tons.

Among the services which it has performed, as enumerated in the records of the Fire Department, are: lifting out horses which have fallen through floors, into trenches or manholes, etc., and moving of large steel columns, as shown in the accompanying illustration, besides taking care of the usual fire apparatus wrecking about the city. As constructed by the International Motor Co. of New York, it can travel at 40 to 45 miles per hour. It requires a squad of six men, three of whom are kept busy both night and day.



BOSTON FIRE DEPARTMENT'S MOTOR TRUCK WRECKER

Its ordinary duties, besides towing wrecked apparatus, include delivering tools and pulling down walls at fire ruins. During the past three years it has been called upon in several hundred accidents, and it averages a dozen calls per week.

Business Notes

THE W. S. BARSTOW MANUFACTURING ASSOCIATION has appointed Robert N. Hodgson sales manager. Mr. Hodgson has resigned as general manager of the Binghamton Light, Heat & Power Co., which, with 22 similar companies, is owned by the Barstow Manufacturing Association. Mr. Hodgson's headquarters will be in New York City.

A new firm of engineers and contractors, to be known as SPENCER, WHITE & PRENTIS, INC., has just been organized with offices at 47 W. 42d St., New York City. The firm is equipped to do construction work of all kinds, specializing in difficult foundation work, underpinning, piledriving of all types, shafts, tunnels, bridges, piers, etc. It is made up of Lazarus White, president, Charles B. Spencer, vice-president, and Edmund A. Prentis, Jr., secretary and chief engineer. All three members of the firm were released recently from war work. Before that, Mr. Spencer was connected with the Underpinning and Foundation Co. and Messrs. White and Prentis with Smith, Hauser & MacIsaac, Incorporated.

THE SMITH-BOOTH-USHER CO., which represents the Lakewood Engineering Co. in Los Angeles and San Francisco, announces that J. A. Kinkead, formerly New York representative of the Parkersburg Iron & Steel Co., has joined its staff. His office will be in the Rialto Bldg., in San Francisco.

THE TRAYLOR ENGINEERING & MANUFACTURING CO., maker of mining, milling, crushing and smelting equipment, Allentown, Penn., announces the return of R. R. Shafter to its sales organization after an absence of two years as general superintendent of the shipyard of the Traylor Shipbuilding Corporation.

THE OSHKOSH MANUFACTURING CO., Oshkosh, Wis., has completed the organization of its new service plan, consisting of a chain of service stations throughout the United States. J. W. Wooley, general sales manager, announces that these stations will carry a complete line of repair parts for all Oshkosh machines and maintain fully equipped shops for the repairing or complete rebuilding of the machinery. An engine and machinery expert is to be in attendance at each repair shop. Besides the equipped service stations a number of substations will be established. This service is thought to be rather an innovation in the contracting field, and complete information regarding it can be obtained by addressing the firm.

THE BLAW-KNOX CO., Pittsburgh, Penn., has appointed Frank O. Leitzell engineer-salesman in the sheet and tin mill specialties department. Mr. Leitzell was formerly with the H. K. Porter Co., of Pittsburgh, as assistant to the general manager.

THE CHAIN BELT CO., Milwaukee, Wis., has appointed Clifford F. Messinger, formerly manager of the mixer sales, as assistant to the vice-president, and Barney F. Devine, formerly assistant manager of mixer sales, to become manager. Russell E. Dean, formerly of the mixer sales department, becomes Eastern manager of mixer sales, and will have offices in New York City.

THE OHIO LOCOMOTIVE CRANE CO., Bucyrus, Ohio, has appointed H. A. Wolcott district manager for its Chicago territory, with offices at Suite 1417 to 1419, in the Lytton Building.

Trade Publications

The following companies have issued trade publications:

THE BLAW-KNOX CO., Pittsburgh, Penn.; catalog, 6 x 9 in., 24 pages, illustrated; explains the construction and use of the various types of Blaw forms.

THE THEW AUTOMATIC SHOVEL CO., Lorain, Ohio; bulletin No. 30, 8½ x 11 in., 20 pages, illustrated; the subject is highway construction, with text and illustrations of steam shovels on highway work; also catalog No. 11, 8½ x 11 in., 12 pages, illustrated, describing products of the company and full-circle swing shovels and cranes, operated by steam, gasoline or electricity.

THE AUSTIN MANUFACTURING CO., Chicago, Ill.; catalog, 9 x 12 in., 12 pages, illustrated; describes the Austin motor sweeper.

THE UNITED STATES CRANE CO., Chicago; catalog No. 190, 6 x 9 in., six pages; covers the installation and operation of 20- and 30-ton locomotive cranes.

THE LEHIGH PORTLAND CEMENT CO., Allentown, Penn., Chicago and Spokane, Wash.; folder, 7½ x 10½ in., six pages; subject, "History Repeats."

THE HASTINGS PAVEMENT CO., 25 Broad St., New York City; folder, 6½ x 6¾ in., four pages, illustrated; describes the use of asphalt blocks for shop floors and the methods of attaching light and heavy machinery to the floors.

THE SMITH ENGINEERING WORKS, manufacturers of rock, ore and gravel handling machinery, 32nd and Locust Sts., Milwaukee, Wis.; catalog, 7½ x 10¾ in., 15 pages, illustrated; subject, jaw crushers.

THE WEBBER CHIMNEY CO., designers and builders of reinforced-concrete chimneys, 1452 McCormick

Bldg., Chicago, Ill.; catalog No. 19, 5 x 8 in., 56 pages, illustrated; describes the design, construction and proportioning of reinforced-concrete steel chimneys for steam boilers.

THE PELTON WATER WHEEL CO., San Francisco and New York; bulletin No. 11, 8 x 10½ in., 12 pages, illustrated, catalogues centrifugal pumps for irrigation and general use.

THE FEDERAL CEMENT TILE CO., 110 S. Dearborn St., Chicago; folder, 9 x 12 in., four pages; describes cement tiling for roofs.

Lumber Prices High and Advancing

Market Is Uncertain and Highly Speculative, Due to Extraordinary Demand and Subnormal Supply

BY ALDEN W. WELCH

It is beginning to look as if there need be no limit to the price of lumber, that buyers will gratefully accept any price, begging only that their orders be accepted. The natural result is that the lumber market has become extremely uncertain; that is, while everybody knows that prices will not fall, nobody is able to predict how much higher per month they will go. Hence, contractors are chary about estimating on work more than a month ahead, and when they can be induced to *guess*, rather than estimate, a future price, it is natural to suppose that the figure will be generous. This is a most unhealthy condition, the uncertainty of which even the lumbermen deplore. It is a condition that eventually will have the effect of slowing up construction, which is now moving forward so satisfactorily.

The immediate reason for this chaos in the lumber market is the unprecedented demand and the wholly inadequate supply. The most conservative estimate is that production is 19% below normal, with the volume of orders 15% above present production. In certain parts of the country production is 50% of capacity—this in spite of the huge and rapidly growing demand both at home and abroad.

REASONS FOR HIGH PRICES

Labor is scarce, expensive and inefficient, freights are high, buyers are insistent and are bidding against one another; these are some of the obvious reasons why prices are high. However, we are less concerned with merely high prices than with the exorbitant prices which a continuation of the present shortage promises. That word "shortage" explains the whole situation, for it is clear that if prices were based upon cost of production instead of upon insufficient supply they would not be exorbitant, however high they might be.

The scarcity is not confined to one or two localities, but may be said to be general. A large dealer in Baltimore asserts that "supplies of lumber in the United States are only 50% of normal," stating furthermore that there is a present shortage of 250,000,000 ft. in world production.

The labor shortage is attributed partly to the fact that this is the farming season, and that many mills depend upon farming labor exclusively. It is doubtful, however, whether labor shortage can be considered as seriously affecting total production. On the other hand, labor certainly does its bit toward boosting the price, inasmuch as wages at the mill are three times the pre-war rate.

During the war, numerous mills which formerly catered only to the export trade were forced by shipping conditions to enter the domestic market. With the return of export facilities—and the high export-price incentive—these mills have resumed exporting, thereby causing an important change in the stock offered on the home market.

ON THE PACIFIC COAST

Although the price of lumber at Los Angeles is nearly double pre-war prices, indications point toward a further advance. Mills in the Northwest are 250,000,000 ft. behind in filling orders, the extraordinary foreign demand being assigned as the principal reason. Shipments from the mills have exceeded production for some time. So many unfilled orders have accumulated at the mills that producers are refusing further requests. The inadequate supply is explained by the eight-hour day now in effect (10 hours during the war), an insufficiency of efficient labor, and wet weather.

The situation on the Pacific coast is further elaborated upon in a report from San Francisco. At the time when it was made known that the Government would order no more wooden vessels (some existing contracts were canceled), the mills tried to induce trade by putting a price on lumber which netted them about $22 per thousand base. At present writing the base is $31.50 for cargo lots (50,000 ft. or over). The rise was occasioned by orders for Eastern export and the home trade.

The mill owner's claim that prices are high all along the line will be readily admitted. For instance, No. 2 fir logs are selling for $17 to $18, delivered at the mill. To this must be added the manufacturing cost, the high ocean freight and the profit.

Again, during the war the Government, through the air service, cut a great many cedar logs out of which a very small percentage of timber was satisfactory for use in Army airplanes. As a result, when production was discontinued, there was stacked up some 30,000,000 ft. of lumber. This stock has at last been disposed of, mostly for foreign account and ship construction. A stiffening of prices has, naturally, resulted.

TAXES LARGELY TO BLAME FOR SHORTAGE

In the foregoing the reasons why lumber is expensive are clear and sufficient, but the serious shortage of supply was not adequately explained. Indications point toward a voluntary curtailment of production on the part of the manufacturers. The reason—the stumpage basis tax and the excess profits tax. It is asserted that a plant having capacity to cut 50,000,000 ft. a year can cut 25,000,000 ft. and make a fair profit, whereas if this amount were exceeded the big end of the profit would go to the Government. The larger operators estimate that their share is $16,000 out of net profits of $100,000. Rather than face these taxes they prefer to conserve their timber. An instance is cited of a lumberman who normally cut 300,000,000 ft. annually, whereas this year he will cut only 100,000,000 ft. Another company, which under normal conditions has a 10-year cut ahead of it, will curtail production rather than pay 80% to the Government, for the ensuing three or four years.

STABILIZE THE MARKET BY ANNOUNCING MONTHLY PRICE SCHEDULES

It must not be overlooked that the extraordinary domestic demand indicates that the country as a whole is prosperous and able to pay high prices for its needs. In the seven days prior to July 24 contracts were let on 50 non-industrial building projects valued at $10,442,000, in addition to the vast amount of residence construction. Nevertheless, there is a limit to the patience and the pocket of the public. Unless a concerted effort is made to stabilize the lumber market, building operations in which lumber is an important factor will be curtailed. It is quite likely that such an undesired condition would be prevented if the large lumber companies would announce monthly schedules of prices which they guaranteed to maintain unchanged throughout the month. Contractors complain less of high prices than of unstable prices. Under the present intolerable conditions they are unable to estimate ahead on work involving large amounts of lumber.

That only the speculators should object to stabilizing the market by announcing monthly price schedules is fairly established by the fact that the Long-Bell Lumber Co., of Kansas City, Mo., has embraced this policy. Its president says, in a bulletin to the trade: "This is to announce that our prices on our yellow-pine lumber, until Aug. 15, will be no higher than now. It shall be our policy to endeavor to protect our trade by stable prices on yellow-pine lumber, if humanly possible."

And this should be the endeavor of all lumber manufacturers and dealers.